

---

# MAPS™ 5G Core Network Emulation

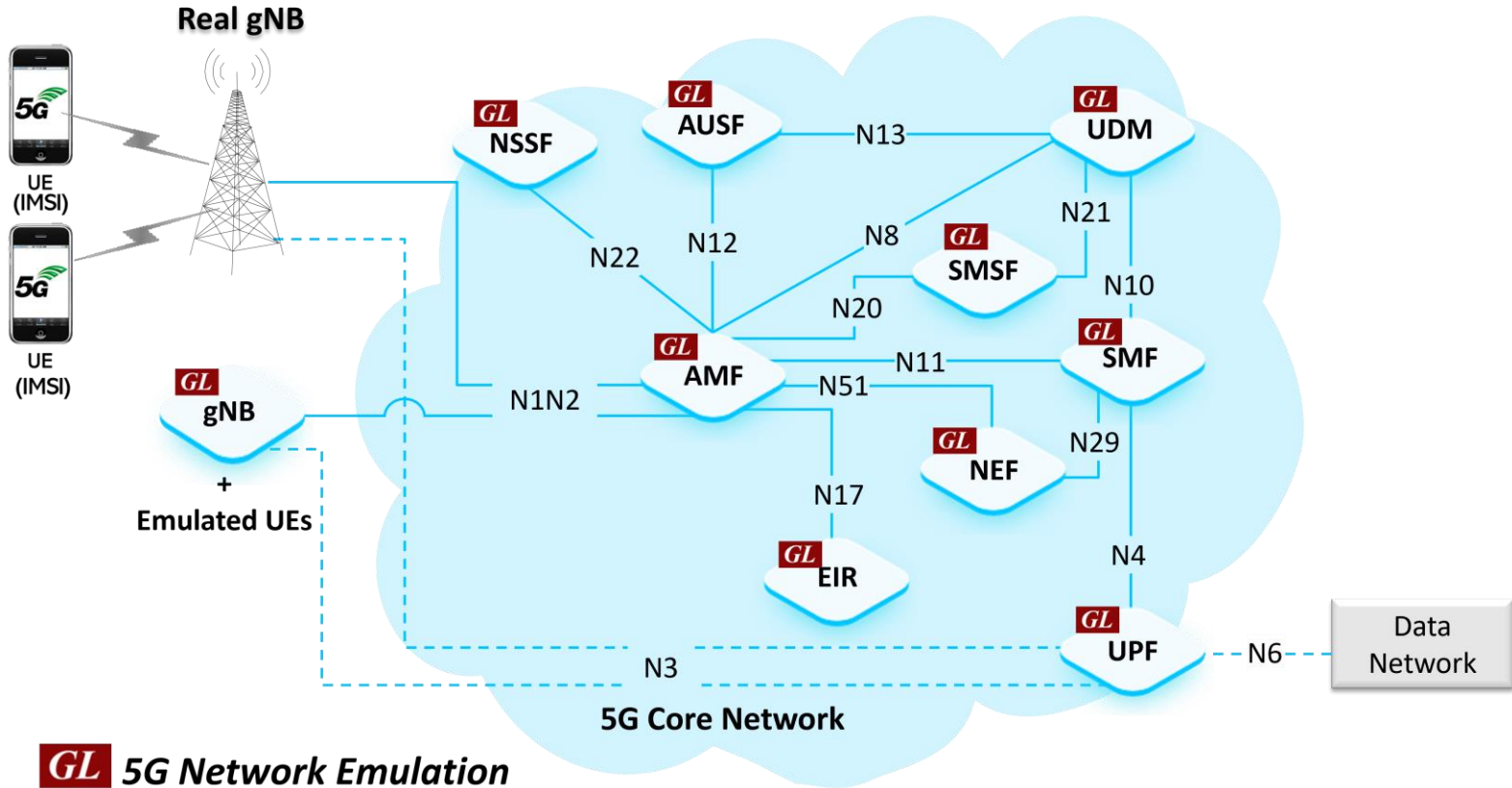
N1N2, N4, N8, N10, N11, N12, N13, N17, N20, N21, N22, N29, N51

---



818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878  
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: [info@gl.com](mailto:info@gl.com)  
Website: <https://www.gl.com>

# 5G Network Diagram



**GL** 5G Network Emulation

# Features

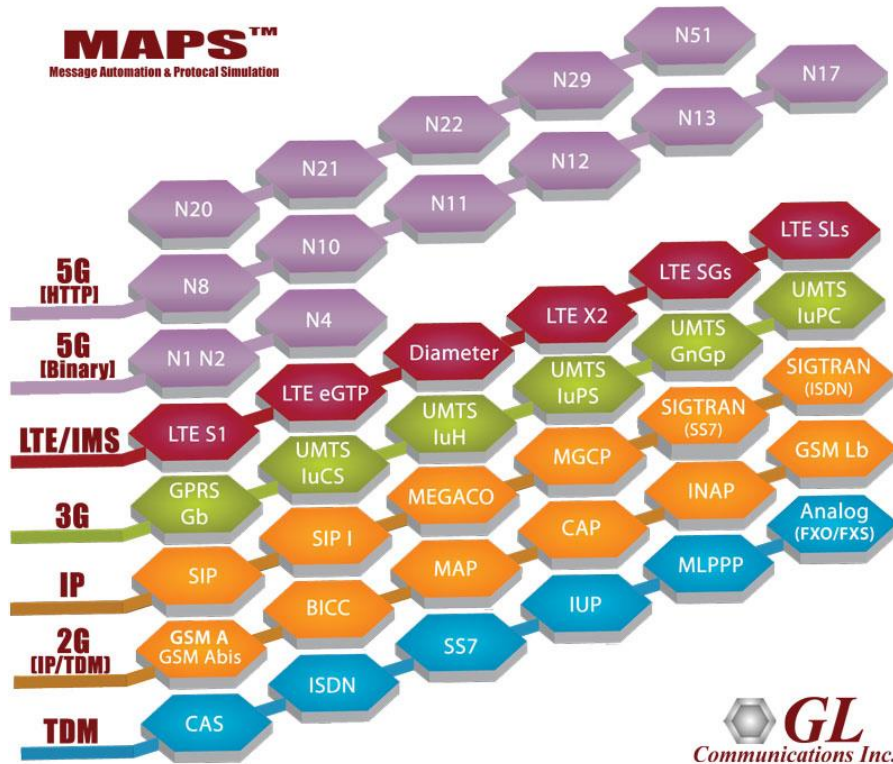
- End-to-End 5G Network Emulation
- MAPS™ 5GC network supports N1N2, N4, N8, N10, N11, N12, N13, N17, N20, N21, N22, N29, and N51 interfaces
- Emulates 5G - UE+gNB, AMF, SMF, AUSF, NSSF, AUSF, UDM, SMSF, NEF, EIR and UPF
- Features Functional Testing, Performance Testing, Inter-Operability Testing and Migration Testing
- Supports, advanced voice feature testing, such as IVR, Voice Recognition and Speech-to-Text
- Emulate Massive UEs (up to 64,000) with Voice Traffic
- Emulate User-plane GTP traffic at high line rates (up to 40 Gbps)
- Assess Voice Quality (eModel, PESQ, POLQA) Supports Control plane signaling and User plane traffic

# Features (Contd.)

- Generate and process NGAP/NAS (valid and invalid) messages
- Supports customization of call flow and message templates using Script and Message Editor
- Supports scripted call generation and automated call reception
- Provides Call Statistics and Events Status
- Voice Quality, Data Retention, Lawful Interception, Fraud Detection
- Record thousands of Voice Calls - Filter & Record Only Calls-Of-Interest
- Capture up to 30,000 Simultaneous Voice Calls
- Supports Command Line Interface (CLI) using Python APIs

# Message Automation and Protocol Simulation (MAPS™)

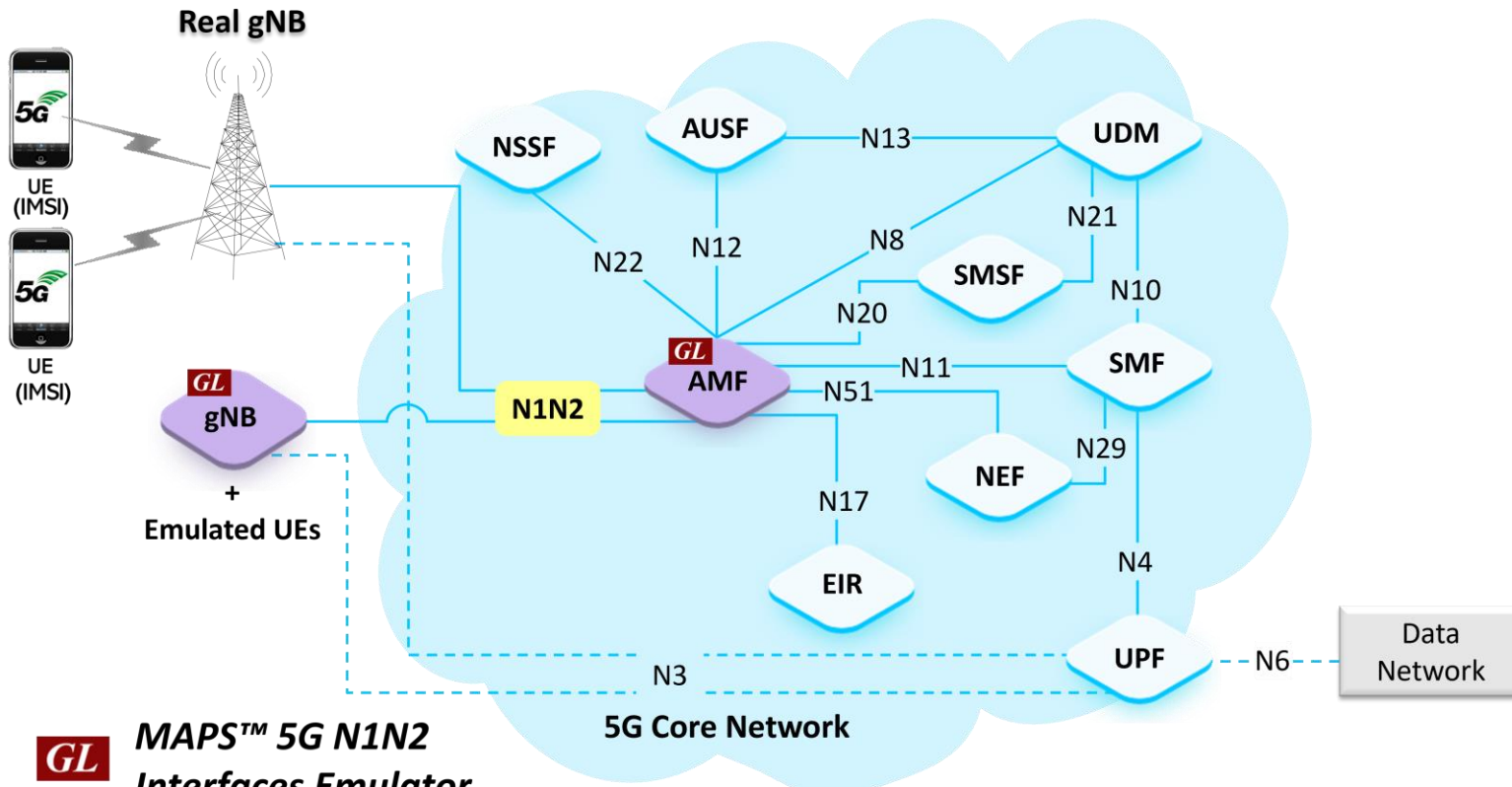
# About MAPS™



- **MAPS** stands for **M**essage **A**utomation and **P**rotocol **S**imulation
- It is a generic framework for the generation of telecommunications protocol messages and transmission of bearer traffic
- **MAPS™** is built on a proprietary scripting language developed by GL Communications
- All **MAPS™** products come with out-of-the-box scripts that act as fully functional state machines for the relevant protocol

# MAPS™ 5G N1 N2 Interface Emulation

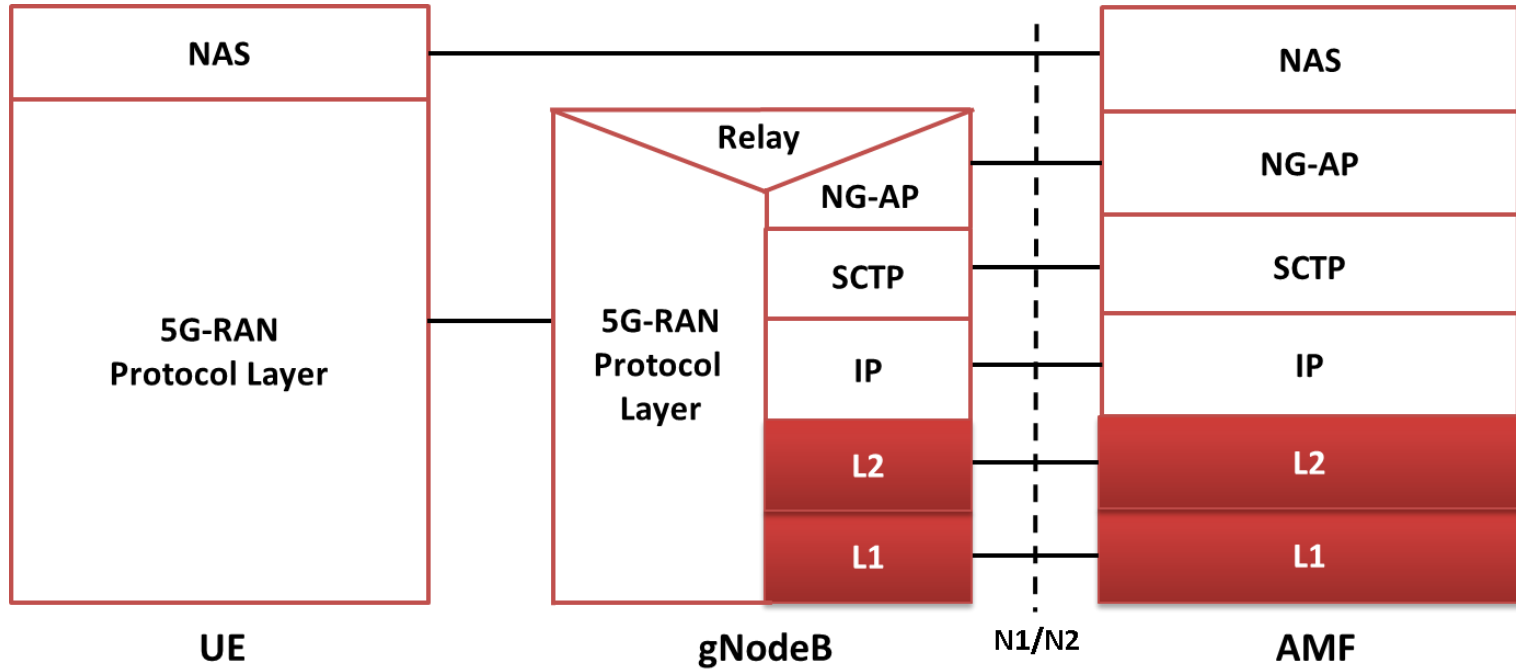
# MAPS™ 5G N1 N2 Interface Network Architecture



**MAPS™ 5G N1N2**  
*Interfaces Emulator*



# Protocol Stack Specification



# Protocol Stack Specification (Contd.)

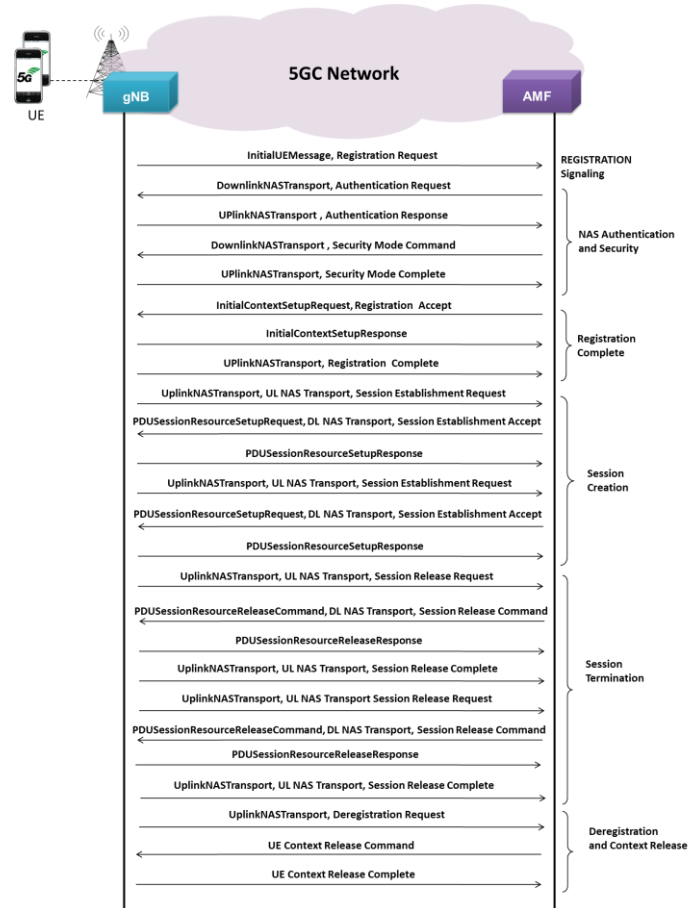
Supported Protocols	Standard / Specification Used
<b>N1N2 Interface</b>	
System Architecture for the 5G	3GPP TS 23.501
Non-Access-Stratum (NAS)	3GPP TS 24.501
NG Application Protocol (NGAP)	3GPP TS 38.413
GPRS Tunneling Protocol for User Plane (GTP-U)	3GPP TS 29.281
SCTP	RFC 2960

- NG Application Protocol (NGAP): Application Layer Protocol between the gNodeB and the AMF
- SCTP for the control plane (SCTP): This protocol guarantees delivery of signaling messages between AMF and gNodeB (N1N2). SCTP is defined in RFC 2960

# MAPS™ 5G N1 N2 Interface Call Procedures

- UE Registration Signalling
  - Initial UE Message
  - Downlink NAS Transport
  - Uplink NAS Transport
  - Registration Procedure
  - Authentication Procedure
  - Security Mode Procedure
  - PDN Connectivity Request
  - Initial Context Setup Procedure
- Session Establishment Procedure
  - Session Establishment Request
  - Session Establishment Accept
- Session Release Procedure
  - Session Release Request
  - Session Release Command
  - Session Release Complete
- Deregistration procedures
  - Deregistration Request
  - Deregistration Accept
- UE Context Release Procedure
  - UE Context Release Command
  - UE Context Release Complete

# MAPS™ 5G N1 N2 Interface Call Scenarios



# MAPS™ 5G N1N2 Interface – Call Generation

## Call Generation (gNB)

The screenshot displays the MAPS gNB (N1N2 RELEASE17) interface for call generation. The top window shows a table of script execution results:

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events Profile	Result	Total Iterations	Completed Iterations
1	5GNGAP_UESessionControl.gls	MSIN3012041631	TMSI_0x0FBD3D81MSI_001013012...	Start	UE CONTEXT RELEASED	Pass	Pass	1	1
2	5GNGAP_UESessionControl.gls	MSIN3012041632		Start		Unknown	Unknown	1	0
3	5GNGAP_UESessionControl.gls	MSIN3012041633		Start		Unknown	Unknown	1	0
4	5GNGAP_UESessionControl.gls	MSIN3012041634		Start		Unknown	Unknown	1	0
5	5GNGAP_UESessionControl.gls	MSIN3012041635		Start		Unknown	Unknown	1	0

The main window shows a detailed message sequence for gNB 0 and AMF 0. The sequence includes:

- InitialUEMessage, Registration Request (11:18:15.231000)
- DownlinkNAS transport, Authentication Request (11:18:16.057000)
- UplinkNAS transport, Authentication Response (11:18:16.058000)
- DownlinkNAS transport, Security Mode Command (11:18:16.157000)
- UplinkNAS transport, Security Mode Complete (11:18:16.158000)
- InitialContextSetupRequest, Registration Accept (11:18:16.267000)
- InitialContextSetupResponse (11:18:16.269000)
- UplinkNAS transport, Registration Complete (11:18:16.270000)
- UplinkNAS transport, UL NAS transport, Session Establishment Request (11:18:16.313000)
- PDU Session Resource Setup Request, DL NAS transport, Session Establishment Accept (11:18:16.458000)
- PDU Session Resource Setup Response (11:18:16.462000)
- UplinkNAS transport, UL NAS transport, Session Establishment Request (11:18:16.466000)
- PDU Session Resource Setup Request, DL NAS transport, Session Establishment Accept (11:18:16.556000)
- PDU Session Resource Setup Response (11:18:16.558000)
- UplinkNAS transport, UL NAS transport, Session Release Request (11:18:25.879000)
- PDU Session Resource Release Command, DL NAS transport, Session Release Command (11:18:25.971000)
- PDU Session Resource Release Response (11:18:25.973000)
- UplinkNAS transport, UL NAS transport, Session Release Complete (11:18:25.973000)
- UplinkNAS transport, UL NAS transport, Session Release Request (11:18:26.974000)

The right pane shows a detailed view of the InitialUEMessage (0) structure:

```
----- NGAP Layer -----  
NGAP-PDU = InitiatingMessage (0)  
InitiatingMessage  
  ProcedureCode = 15 id-InitialUEMessage  
  procedureCriticality = 0 reject(0)  
  Value  
    InitialUEMessage  
      ProtocolIE-Container = 6 Items  
      Item  
        ProtocolIE-Field = 88 id-RAN-UE-NGAP-ID  
        ProtocolIE-ID = 88 id-RAN-UE-NGAP-ID  
        procedureCriticality = 0 reject(0)  
        Value  
          RAN-UE-NGAP-ID = 3  
          Item = 1  
          ProtocolIE-Field = 38 id-RAS-PDU  
          ProtocolIE-ID = 38 id-RAS-PDU  
          procedureCriticality = 0 reject(0)  
          Value  
            RAS-PDU = x7E004171000D0100F110000  
            Item = 2  
            ProtocolIE-Field = 121 id-UserLocationInform  
            ProtocolIE-ID = 121 id-UserLocationInform  
            procedureCriticality = 0 reject(0)  
            Value  
              UserLocationInformation  
                userLocationInformationNR  
                nr-CGI  
                plMNIdentity = 001  
                MCC = 01  
                MNC = 000000000  
                nrCellIdentity = 000000000  
                tAI  
                plMNIdentity = 001  
                MCC = 01  
                MNC = x000001  
                tAC = 3  
            ProtocolIE-Field = 90 id-RRCEstablishmentCa  
            ProtocolIE-ID = 90 id-RRCEstablishmentCa  
            procedureCriticality = 0 reject(0)
```

# MAPS™ 5G N1N2 Interface – Call Reception

## Call Reception (AMF)

The screenshot displays the MAPS AMF (N1N2 RELEASE17) interface for Call Reception. The top window shows a table of script execution results:

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Results
1	NGAPManagementHandler.gls		RANName.gnb00000001_gNBId..0x1000001_ConnectorId.1001	Stop	NG Setup Successful	SendAMFConfigurationUpdate		Pass
2	AMFSessionControl.gls		MSIN..3012041631	Completed	UE CONTEXT RELEASED	None		Pass

The main window shows a message sequence for gNB 0 and AMF. The sequence includes:

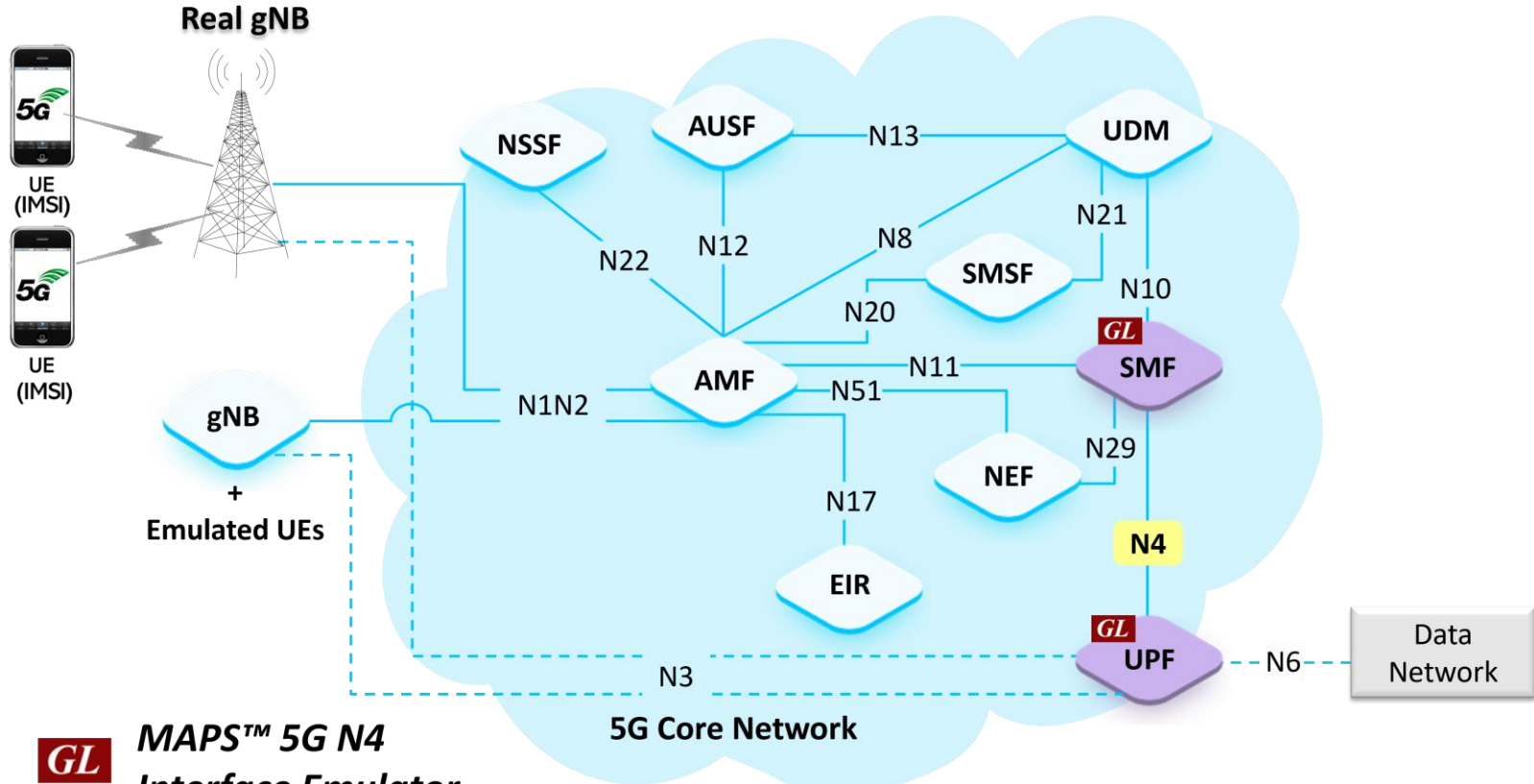
- InitialUEMessage, Registration Request (16:50:59.752000)
- DownlinkNAS Transport, Authentication Request (16:50:59.821000)
- UplinkNAS Transport, Authentication Response (16:50:59.991000)
- DownlinkNAS Transport, Security Mode Command (16:51:00.006000)
- UplinkNAS Transport, Security Mode Complete (16:51:00.188000)
- InitialContextSetupRequest, Registration Accept (16:51:00.210000)
- InitialContextSetupResponse (16:51:00.390000)
- UplinkNAS Transport, Registration Complete (16:51:00.395000)
- UplinkNAS Transport, UL NAS Transport, Session Establishment Request (16:51:00.400000)
- PDU Session Resource Setup Request, DL NAS Transport, Session Establishment Accept (16:51:00.423000)
- PDU Session Resource Setup Response (16:51:00.590000)
- UplinkNAS Transport, UL NAS Transport, Session Establishment Request (16:51:00.596000)
- PDU Session Resource Setup Request, DL NAS Transport, Session Establishment Accept (16:51:00.606000)
- PDU Session Resource Setup Response (16:51:00.690000)
- UplinkNAS Transport, UL NAS Transport, Session Release Request (16:52:00.793000)
- PDU Session Resource Release Command, DL NAS Transport, Session Release Command (16:52:00.809000)
- PDU Session Resource Release Response (16:52:00.884000)
- UplinkNAS Transport, UL NAS Transport, Session Release Complete (16:52:00.984000)
- UplinkNAS Transport, UL NAS Transport, Session Release Request (16:52:00.988000)
- PDU Session Resource Release Command, DL NAS Transport, Session Release Command (16:52:00.993000)
- PDU Session Resource Release Response (16:52:00.085000)
- UplinkNAS Transport, UL NAS Transport, Session Release Complete (16:52:00.999000)

The right pane shows a detailed view of the InitialUEMessage (0) message:

```
===== NGAP Layer =====  
NGAP-PDU = InitiatingMessage (0)  
InitiatingMessage = 16 id-InitialUEMessage  
ProcedureCode = 0 reject (0)  
Value =  
InitialUEMessage =  
ProtocolIE-Container = 6 Items  
Item = 0  
ProtocolIE-Field = 85 id-RAN-UE-NGAP-ID  
ProtocolIE-ID = 0 reject (0)  
procedureCriticality = 0 reject (0)  
Value =  
RAN-UE-NGAP-ID = 2  
Item = 1  
ProtocolIE-Field = 38 id-RAS-PDU  
ProtocolIE-ID = 0 reject (0)  
procedureCriticality = 0 reject (0)  
Value =  
NAS-PDU = N7E004710000D100F11000000000321406  
NAS-PDU = 2  
Item =  
ProtocolIE-Field = 121 id-UserLocationInformation  
ProtocolIE-ID = 0 reject (0)  
procedureCriticality = 0 reject (0)  
Value =  
UserLocationInformation = userLocationInformationNR (1)  
userLocationInformationNR =  
nr-CGI =  
pLMNIdentity =  
0042 MCC = 001  
0043 MNC = 01  
nrCellIdentity = 000000000  
tAI =  
pLMNIdentity =  
004A MCC = 001  
004B MNC = 01  
tAC = X000001  
Item = 3  
ProtocolIE-Field = 90 id-RRCEstablishmentCause  
ProtocolIE-ID = 0 reject (0)  
procedureCriticality = 0 reject (0)  
Value =  
RRCEstablishmentCause = 3 mo-Signalling(3)  
Item = 4  
ProtocolIE-Field = 3 id-AMFSetID  
ProtocolIE-ID = 0 reject (0)  
procedureCriticality = 0 reject (0)
```

# MAPS™ 5G N4 Interface Emulation

# MAPS™ 5G N4 Network Architecture



**MAPS™ 5G N4**  
**Interface Emulator**



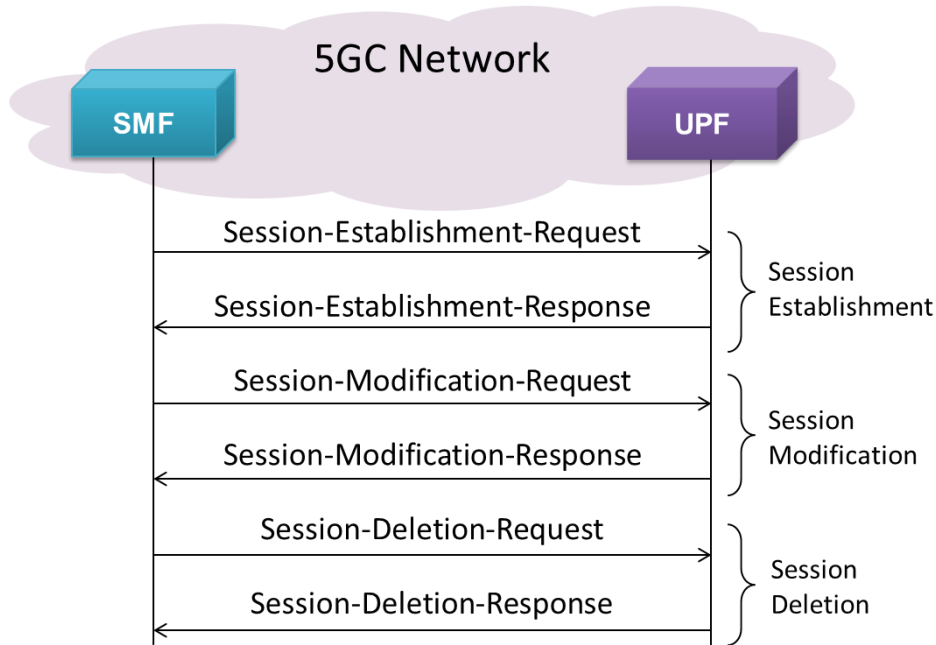
# Protocol Stack Specification

PFCP
UDP
IP
L2
L1

Supported Protocols	Standard / Specification Used
<b>N4 Interface</b>	
N4 Interface (SMF - UPF)	TS29.244
PFCP	3GPP TS 23.501 [28] 3GPP TS 23.502 [29]
UDP	IETF RFC 768
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

- PFCP entity supports IPv4 protocol

# MAPS™ 5G N4 Call Scenarios



- PFCP Session Establishment Procedure
  - Session Establishment Request
  - Session Establishment Accept
- PFCP Session Modification Procedure
  - Session Modification Request
  - Session Modification Response
- PFCP Session Deletion Procedure
  - Session Deletion Request
  - Session Deletion Response

# MAPS™ 5G N4 Interface – Call Emulation

## Call Generation

MAPS SMF (N4 RELEASE17) - [Call Generation - CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Exec...	Status	Events	Events Profile	Result	Total Iterat...	Completed Iterations
1	PFCPSessionControl.gls	Profile	SMFSEID : 0x03, UPFSEID : 0x00000000000002712	Start	SESSION-TERMINATED	None		Pass	1	1
2	PFCPSessionControl.gls			Start		None		Unknown	1	0
3	PFCPSessionControl.gls			Start		None		Unknown	1	0
4	PFCPSessionControl.gls			Start		None		Unknown	1	0

Add Delete Insert Refresh Start Start All Stop Stop All Abort Abort All

Save Column Width Show Latest

SMF UPF

Session Establishment Request → 10.13.43.633000

Session Establishment Response ← 10.13.43.649000

Session Modification Request → 10.13.43.649000

Session Modification Response ← 10.13.43.671000

Session Deletion Request → 10.13.46.463000

Session Deletion Response ← 10.13.46.483000

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events

## Call Reception

MAPS UPF (N4 RELEASE17) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Results
1	UPF_HTTP2_Connection_Monitor.gls		UPF Server Clients : UPF,	Stop	Monitoring HTTP2 Connection Status	None		Unknown
2	NRF_ResourceMonitor.gls		ConnectionID : 1	Stop		None		Unknown
3	PFCPManagementHandler.gls			Stop	Heartbeat Success	None		Pass
4	UPFSessionControl.gls		UEIPAddress : 192.168.15.141.SMFSEID : 0x000000	Completed	Session Deletion Response Sent	None		Pass
5	UPFSessionControl.gls		UEIPAddress : 192.168.15.142.SMFSEID : 0x000000	Completed	Session Deletion Response Sent	None		Pass

Stop Stop All Abort Abort All Show Records Select Active Call Auto Trash Trash Show Hidden Calls

Save Column Width Show Latest

SMF UPF

Session Establishment Request → 10.13.43.640000

Session Establishment Response ← 10.13.43.641000

Session Modification Request → 10.13.43.659000

Session Modification Response ← 10.13.43.659000

Session Deletion Request → 10.13.46.473000

Session Deletion Response ← 10.13.46.473000

Scripts Message Sequence Event Config Script Flow

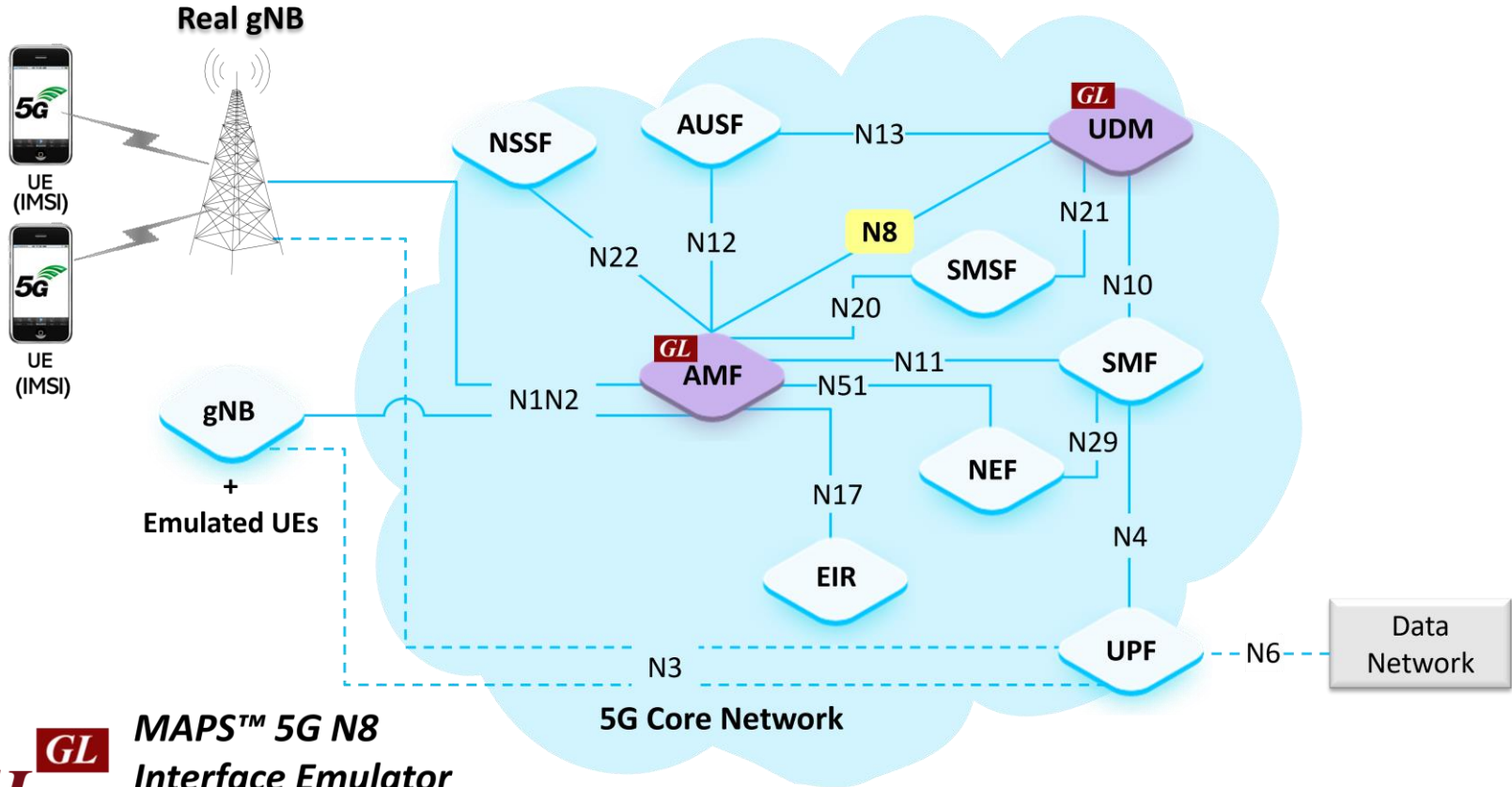
Initialisation Errors Error Events Captured Errors Link Status Up=0 Down=0

```

===== PFCP Layer =====
0000 S
0000 Message Priority: = .....1 SEID field is present
0000 FO (Follow On) = .....1. Present
0000 Spare = .....0. Not Present
0000 Version = .....00... (0)
0001 Message Type = 001..... PFCP Version 1
0002 Length = 00110010 Session Establishment Req
0004 Session Endpoint Identifier = 156 (x005C)
000C Sequence Number = x0000000000000000
000F Spare = 0 (x000000)
000F Message Priority = .....0000 (0)
0010 Information Element Id = 0000.... (0)
0012 Length = x003C Node ID
0014 Node ID Type = .....0000 IPv4 address
0014 Space = 0000.... (0)
0015 IPv4 Address = 192.168.12.99 (x0CA80C59)
CP F-SEID
    
```

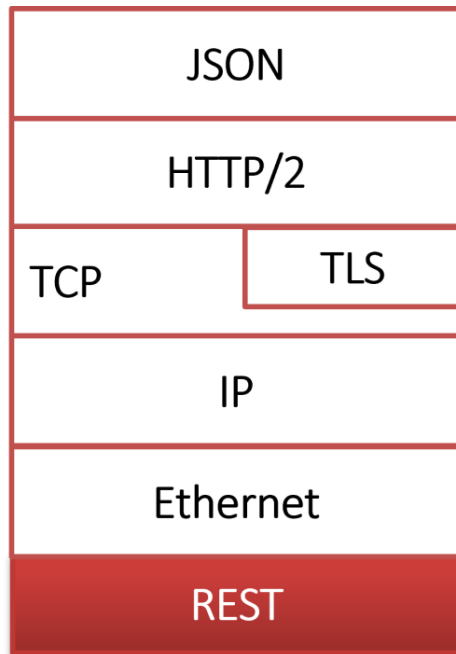
# MAPS™ 5G N8 Interface Emulation

# MAPS™ 5G N8 Network Architecture



MAPS™ 5G N8  
Interface Emulator

# Protocol Stack Specification



Supported Protocols	Standard / Specification Used
<b>N8 Interface</b>	
N8 Interface (UDM - AMF)	TS29.503
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP HTTP / 2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™5G N8 Interface Procedures

- Nudm\_UEContextManagement Service
  - AMF registration for 3GPP access
  - Update AMF registration for 3GPP access
  - AMF deregistration for 3GPP access
  - UDM Initiated NF(AMF) Deregistration for 3GPP access
  - AMF registration for Non 3GPP access
  - Update AMF registration for Non 3GPP access
  - AMF deregistration for Non 3GPP access
  - UDM Initiated NF(AMF) Deregistration for NON 3GPP Access
  - UDM initiated P-CSCF-Restoration
- Nudm\_SubscriberDataManagement Service
  - Slice Selection Subscription Data Retrieval
  - Access and Mobility Subscription Data Retrieval
  - SMF Selection Subscription Data Retrieval
  - SMS Subscription Data Retrieval
  - Retrieval Of Multiple Data Sets
  - UE Context in SMF Data Retrieval
  - UE Context In SMSF Data Retrieval
  - LCS Mobile Originated Data Retrieval
  - Subscription to notifications of data change
  - Modification of a subscription to notifications of data change
  - Unsubscribe to notifications of data change

# MAPS™ 5G N8 Interface – Call Emulation

## Call Generation

MAPS AMF (N8 RELEASE17) - [Call Generation -Default]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Ev...	Result	Total It...	Completed Iterations
1	Nudm_UECM_Control.gls	UEProfile0001	SUPI :imsi-001013012041631	Start	AMF Registration is successful	None		Pass	1	1
2	Nudm_SDM_Control.gls	UEProfile0001		Start		None		Unknown	1	0

AMF UDM

PUT /nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access 15:49:58.596000

201 CREATED 15:49:58.979000

## Call Reception

MAPS UDM (N8 RELEASE17) - [Call Reception]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Results
1	UDM_HTTP2_Connection_Monitor.gls		UDM Server Clients : AMF	Stop	Monitoring HTTP2 Connection Status	None		Unknown
2	Nudm_UECM_Control.gls		SUPI :imsi-001013012041631	Completed	AMF Registration is updated	None		Pass
3	Nudm_SDM_Control.gls		SUPI :imsi-001013012041631	Completed	Successful Response Sent	None		Pass

AMF UDM

PUT /nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access 15:49:58.961000

201 15:49:58.970000

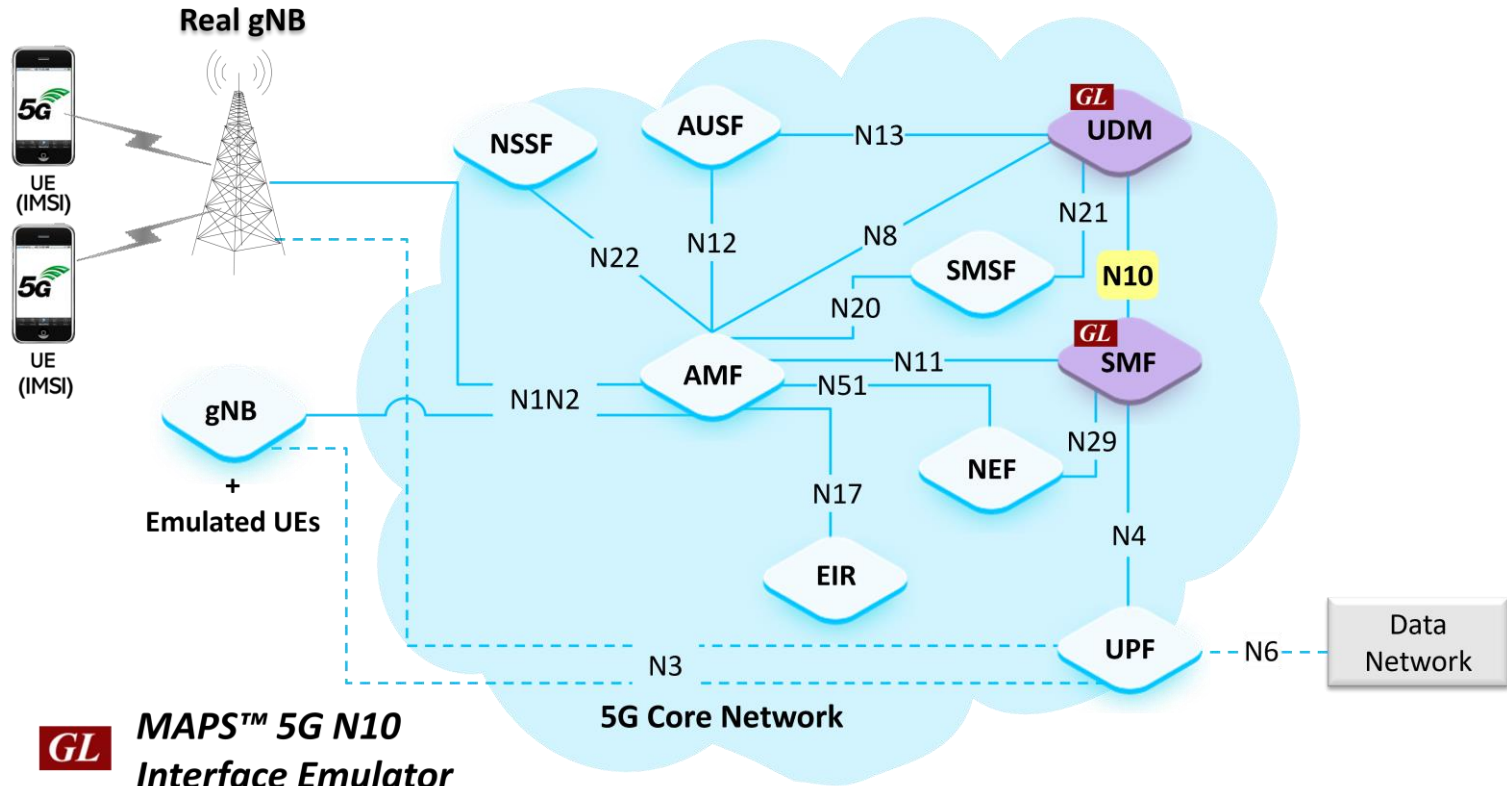
```
Status: 3
method: PUT
path: /nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access
scheme: http
authority: 192.168.12.198:6666
content-type: application/json
accept: application/json,
application/problem+json
content-length: 317

{
  "amfInstanceId": "f19d267b-dd40-4276-b396-92437d45c35e",
  "deregCallbackUri": "http://192.168.12.170:6666/nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access"
}
```



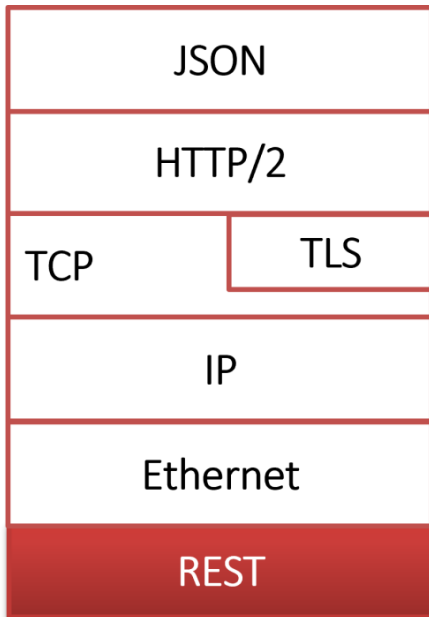
# MAPS™ 5G N10 Interface Emulation

# MAPS™ 5G N10 Network Architecture



**GL** MAPS™ 5G N10  
Interface Emulator

# Protocol Stack Specification



Supported Protocols	Standard / Specification Used
<b>N10 Interface</b>	
N10 Interface (UDM - SMF)	TS29.503 Release 15
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP / 2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™ 5G N10 Interface Procedures

- Nudm\_SubscriberDataManagement Services:
  - Session Management Subscription Data Retrieval
  - Subscription to Notifications of Data Change
  - Modification of a subscription to notifications of data change
  - Unsubscribe to notifications of data change
- Nudm\_UEContextManagement Services:
  - SMF registration
  - SMF deregistration
  - SMF Deregistration Notification
  - UDM Initiated P-CSCF-Restoration Notification

# MAPS™ 5G N10 Interface - Call Emulation

## Call Generation

MAPS SMF (N10 RELEASE17) - [Call Generation -CallGenDefault]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total It...	Completed Iterations
1	Nudm_UECM_Control.gls	UEProfile0001	SUPI :_imsi-001013012041631	Start	SMF Registration is successful	None	Pass	1	1
2	Nudm_SDM_Control.gls	UEProfile0001	SUPI :_imsi-001013012041631	Start	UE's SM Data Received	None	Pass	1	1

Message Sequence Diagram:

```
sequenceDiagram
    participant SMF
    participant UDM
    SMF->>UDM: GET /nudm-sdm/v2/imsi-001013012041631/sm-data?dnn=internet
    Note over SMF,UDM: 12:36:33.716000
    UDM-->>SMF: 200 OK
    Note over SMF,UDM: 12:36:34.111000
```

## Call Reception

MAPS UDM (N10 RELEASE17) - [Call Reception]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Results
1	UDM_HTTP2_Connection_Monitor.gls		UDM Server Clients :_SMF,	Stop	Monitoring HTTP2 Connection Status	None		Unknown
2	Nudm_UECM_Control.gls		SUPI :_imsi-001013012041631	Completed	SMF Registration is updated	None		Pass
3	Nudm_SDM_Control.gls		SUPI :_imsi-001013012041631	Completed	Successful Response Sent	None		Pass

Message Sequence Diagram:

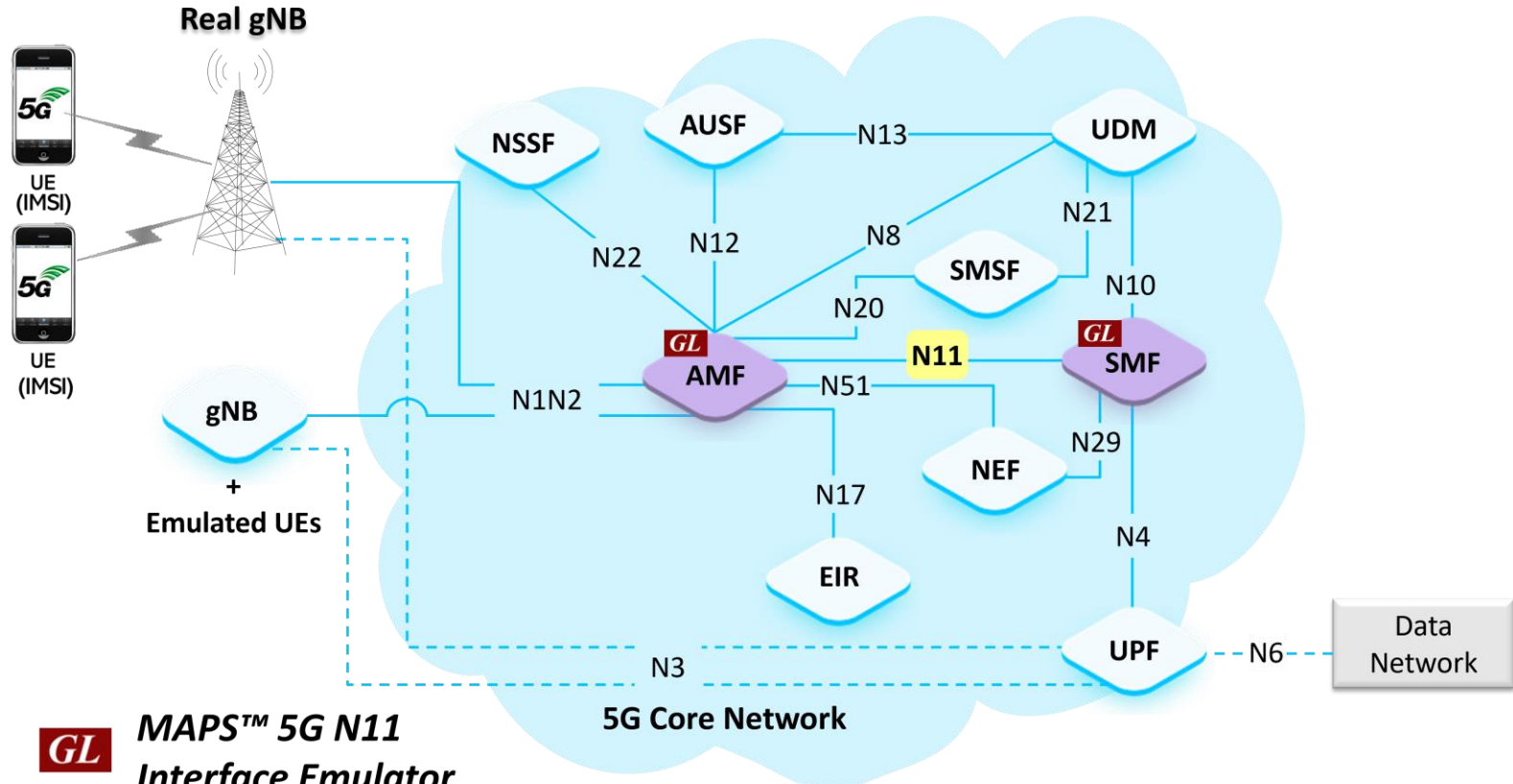
```
sequenceDiagram
    participant SMF
    participant UDM
    SMF->>UDM: GET /nudm-sdm/v2/imsi-001013012041631/sm-data
    Note over SMF,UDM: 12:36:34.092000
    UDM-->>SMF: 200
    Note over SMF,UDM: 12:36:34.104000
```

Response Details:

```
Status: 0
:method : GET
:path : /nudm-sdm/v2/imsi-001013012041631/sm-data?dnn=internet
:scheme : http
:authority : 192.168.12.198:6666
:accept : application/json,
application/problem+json
```

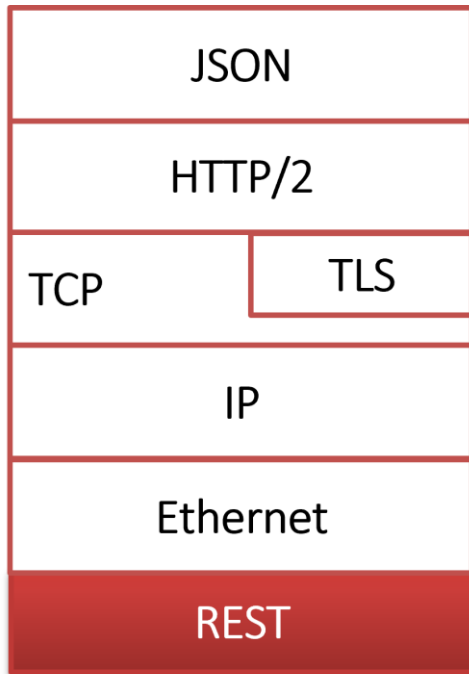
# MAPS™ 5G N11 Interface Emulation

# MAPS™ 5G N4 Network Architecture



MAPS™ 5G N11  
Interface Emulator

# Protocol Stack Specification



Supported Protocols	Standard / Specification Used
N11 Interface (SMF - AMF)	TS29.502
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP / 2 (Hypertext Transfer Protocol)	3GPP TR 21.905 IETF RFC 7540 IETF RFC 7232 IETF RFC 7234
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]



# MAPS™ 5G N11 Interface Procedures

- Nsmf\_PDUSession Services
  - Create SM Context Service Operation
  - Update SM Context Service Operation
  - Release SM Context Service Operation
  - Notify SM Context Status Service Operation
  - Retrieve SM Context Service Operation
- Nudm\_UEContextManagement Service
  - Network triggered Service Request
  - PDU Session establishment
  - PDU Session modification
  - PDU Session release
  - Session continuity, service continuity and UP path management
  - Inter NG-RAN node N2 based handover
  - SMS over NAS procedures
  - UE assisted and UE based positioning procedure
  - Network assisted positioning procedure
  - UE configuration update procedure for transparent UE policy delivery

# MAPS™ 5G N11 Interface - Call Emulation

## Call Generation

MAPS AMF (N11 RELEASE17) - [Call Generation - CallGenDefault]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Itera
1	Nsmf_Session_Control.gls	MSIN3012041631	msi-001013012041631	Start	SM Context Released	None	Pass	1	1
2	Nsmf_Session_Control.gls	MSIN3012041632		Start			Unknown	1	0

Message Sequence Diagram:

- AMF to SMF: POST /nsmf-pdusession/v1/sm-contexts (16:18:53.008000)
- SMF to AMF: 201 CREATED (16:18:53.707000)
- AMF to SMF: POST /nsmf-comm/v1/ue-contexts/msi-001013012041631\_2/n1-n2-messages (16:18:53.818000)
- SMF to AMF: 200 (16:18:53.818000)
- AMF to SMF: POST /nsmf-pdusession/v1/sm-contexts/msi-001013012041631\_2/modify (16:18:53.916000)
- SMF to AMF: 201 CREATED (16:18:53.951000)
- AMF to SMF: POST /nsmf-pdusession/v1/sm-contexts/msi-001013012041631\_2/release (16:19:52.760000)
- SMF to AMF: 204 NO-CONTENT (16:19:52.793000)

## Call Reception

MAPS SMF (N11 RELEASE17) - [Call Reception]

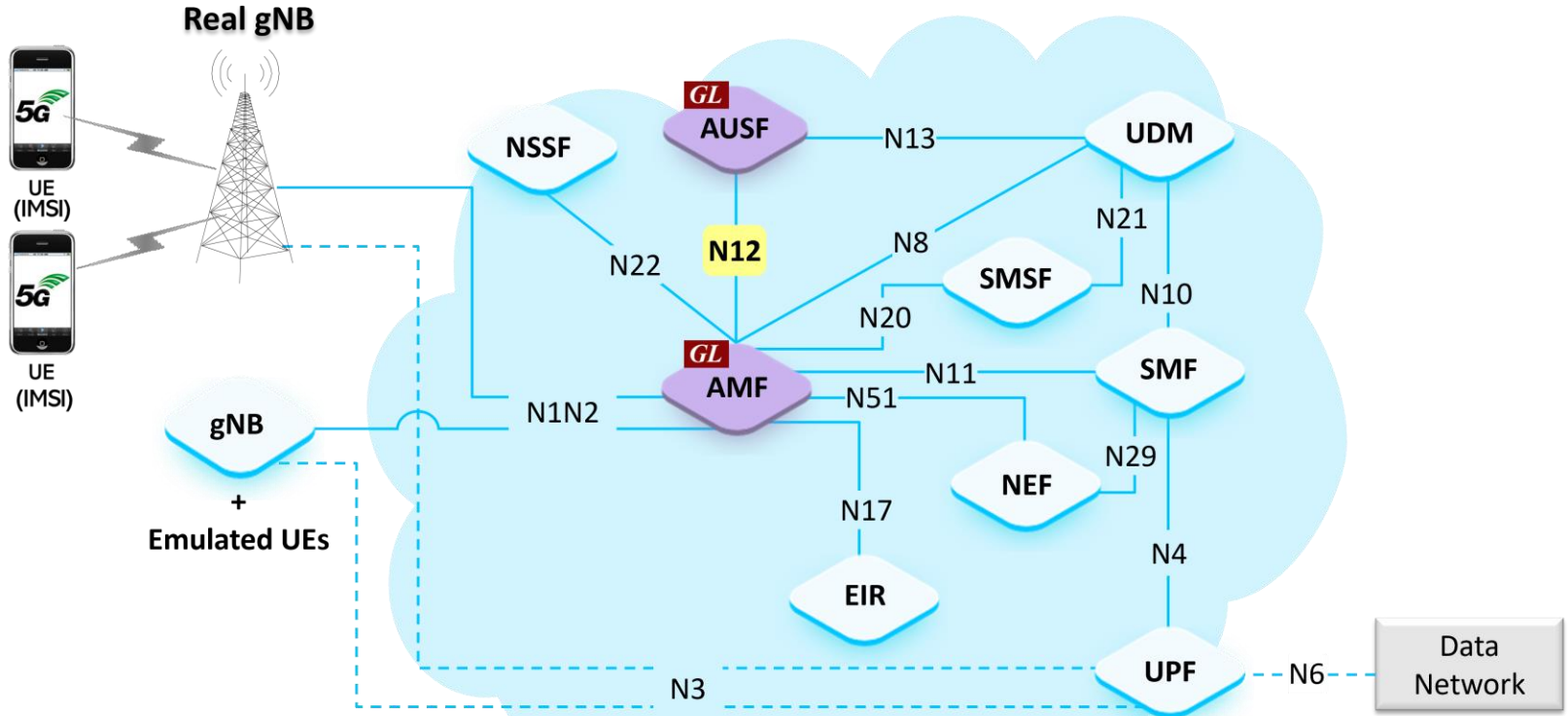
Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	SMF_HTTP2_Connection_Monitor.gls		SMF Server Clients : AMF,	Stop		Connect Server	Unknown
2	Nsmf_Session_Control.gls		SUPIorGPSI::msi-001013012041631_DNN .internet	Completed	SM Context Released	None	Pass

Message Sequence Diagram:

- AMF to SMF: POST /nsmf-pdusession/v1/sm-contexts (16:18:53.567000)
- SMF to AMF: 201 (16:18:53.639000)
- AMF to SMF: POST /nsmf-comm/v1/ue-contexts/msi-001013012041631\_2/n1-n2-messages (16:18:53.791000)
- SMF to AMF: 200 OK (16:18:53.825000)
- AMF to SMF: POST /nsmf-pdusession/v1/sm-contexts/msi-001013012041631\_2/modify (16:18:53.930000)
- SMF to AMF: 201 (16:18:53.946000)
- AMF to SMF: POST /nsmf-pdusession/v1/sm-contexts/msi-001013012041631\_2/release (16:19:52.771000)
- SMF to AMF: 204 (16:19:52.783000)

# MAPS™ 5G N12 Interface Emulation

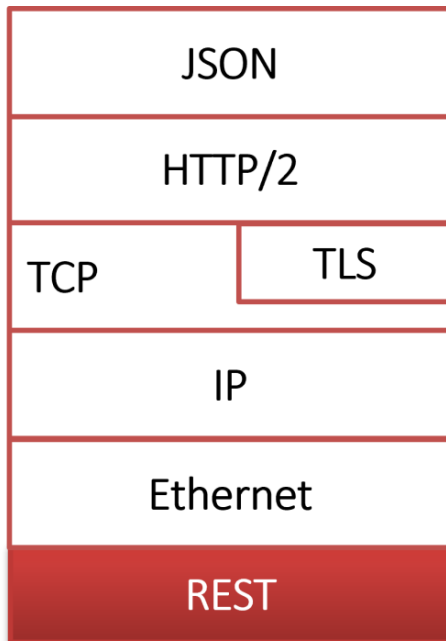
# MAPS™ 5G N12 Interface



**MAPS™ 5G N12**  
**Interface Emulator**



# Protocol Stack Specification



Supported Protocols	Standard / Specification Used
<b>N12 Interface</b>	
N12 Interface (AUSF - AMF)	TS29.509
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP/2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™ 5G N12 Interface Procedures

- Nausf\_UEAuthentication (Authentication and Key Agreement)
- Authentication Result Removal with 5G AKA method

# MAPS™ 5G N12 Interface - Call Emulation

## Call Generation

MAPS AMF (N12 RELEASE17) - [Call Generation - CallGenDefault]

Sr...	Script Name	Profile	Call Info	Script Execu...	Status	Events	Events Profile	Result
1	Nausf_AMF_UEAuthentication_Request.gls	UEProfile0001	suci-0-001-01-0-0-0-3012041631	Start	Authentication Successful	None		Pass
2	Nausf_AMF_UEAuthentication_Request.gls	UEProfile0002		Start		None		Unknown
3	Nausf_AMF_UEAuthentication_Request.gls	UEProfile0003		Start		None		Unknown

Message Sequence Diagram:

```
sequenceDiagram
    participant AMF
    participant AUSF
    AMF->>AUSF: POST /nausf-auth/v1/ue-authentications
    AUSF-->>AMF: 201 CREATED
    AMF->>AUSF: PUT /nausf-auth/v1/ue-authentications/AuthCtx_001013012041631/5g-a
    AUSF-->>AMF: 200 OK
```

## Call Reception

MAPS AUSF (N12 RELEASE17) - [Call Reception]

SrNo	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Results
1	AUSF_HTTP2_Connection_Monitor.gls		AUSF Server Clients : AMF	Stop	Monitoring HTTP2 Connection Status	None		Unknown
2	Nausf_Control.gls		suci-0-001-01-0-0-0-3012041631	Completed	Authentication Vectors sent	None		Pass
3	Nausf_Control.gls		AuthCtx_001013012041631	Completed	5G_AKA_ConfirmationResponseSent	None		Pass

Message Sequence Diagram:

```
sequenceDiagram
    participant AMF
    participant AUSF
    AMF->>AUSF: POST /nausf-auth/v1/ue-authentications
    AUSF-->>AMF: 201
```

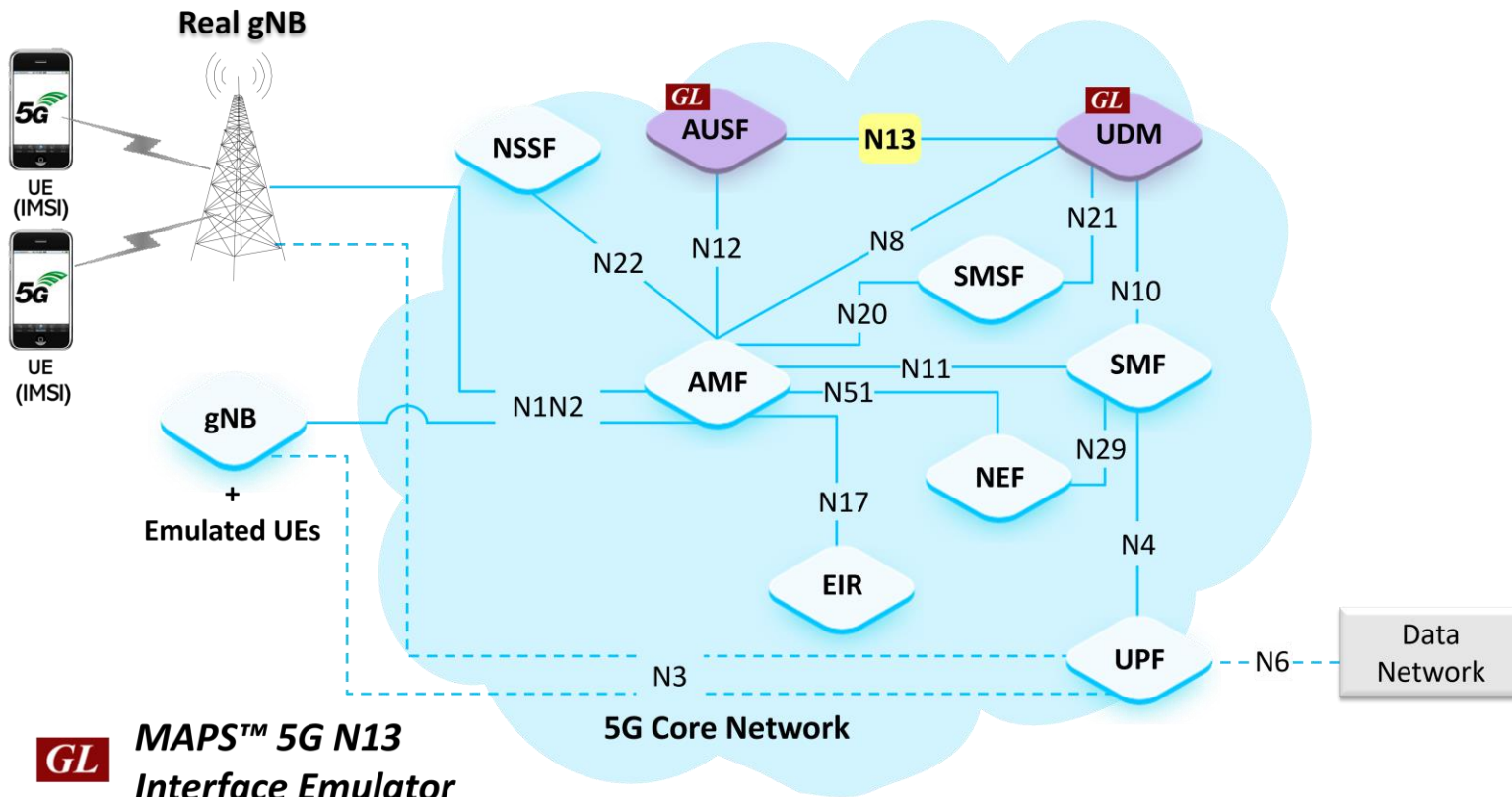
Script Execution Details:

```
Status: 1
:method : POST
:path : /nausf-auth/v1/ue-authentications
:scheme : http
:authority : 192.168.12.37:6666
:content-type : application/json
:accept : application/3gppHal+json, application/problem+json
:content-length : 103
{
  "servingNetworkName": "5G:mnc001.mcc001.3gppnetwork.org",
  "supiOrSuci": "suci-0-001-01-0-0-0-3012041631"
}
```

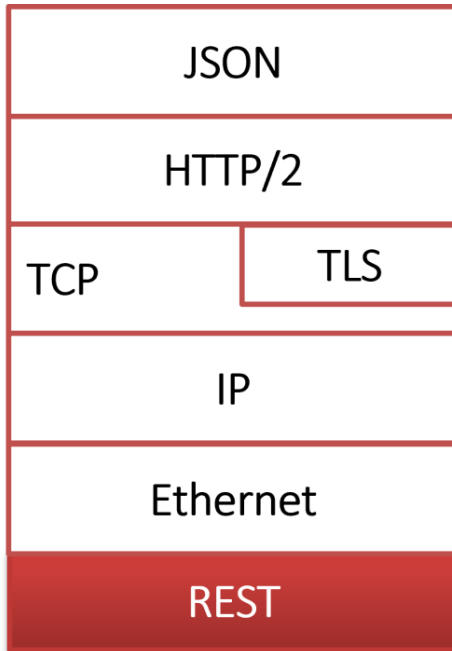
# MAPS™ 5G N13 Interface Emulation



# MAPS™ 5G N13 Interface



# Protocol Stack Specification



Supported Protocols	Standard / Specification Used
<b>N13 Interface</b>	
N13 Interface (UDM - AUSF)	TS29.509
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP / 2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™ 5G N13 Interface Procedures

- Nudm\_UEAuthentication Service
  - Authentication Information Retrieval
  - Authentication Confirmation
  - Authentication Result Removal

# MAPS™ 5G N13 Interface - Call Emulation

## Call Generation

MAPS AUSF (N13 RELEASE17) - [Call Generation - Default]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterations
1	Nudm_UEAU_AUSF_Control.gls	UEProfile0001	suci-0-001-01-0-0-0-3012041631	Start	Authentication Successful	None	Pass	1	1
2	Nudm_UEAU_AUSF_Control.gls	UEProfile0002		Start		None	Unknown	1	0
3	Nudm_UEAU_AUSF_Control.gls	UEProfile0003		Start		None	Unknown	1	0
4	Nudm_UEAU_AUSF_Control.gls	UEProfile0004		Start		None	Unknown	1	0
5	Nudm_UEAU_AUSF_Control.gls	UEProfile0005		Start		None	Unknown	1	0

Message Sequence Diagram:

```
sequenceDiagram
    participant AUSF
    participant UDM
    AUSF->>UDM: POST /nudm-ueau/v1/suci-0-001-01-0-0-0-3012041631/security-information/generate-auth-data
    Note over AUSF,UDM: 12:27:03.967000
    UDM-->>AUSF: 200 OK
    Note over AUSF,UDM: 12:27:04.102000
    AUSF->>UDM: POST /nudm-ueau/v1/imsi-001013012041631/auth-events
    Note over AUSF,UDM: 12:27:04.225000
    UDM-->>AUSF: 201 CREATED
    Note over AUSF,UDM: 12:27:04.253000
```

## Call Reception

MAPS UDM (N13 RELEASE17) - [Call Reception]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	UDM_HTTP2_Connection_Monitor.gls		UDM Server Clients : AUSF	Stop	Monitoring HTTP2 Connection Status	None	Unknown
2	Nudm_UEAU_Control.gls		suci-0-001-01-0-0-0-3012041631	Completed	Authentication Vectors sent	None	Pass
3	Nudm_UEAU_Control.gls		imsi-001013012041631	Completed	Authentication Vectors sent	None	Pass
4	Nudm_UEAU_Control.gls		suci-0-001-01-0-0-0-3012041632	Completed	Authentication Vectors sent	None	Pass
5	Nudm_UEAU_Control.gls		imsi-001013012041632	Completed	Authentication Vectors sent	None	Pass

Message Sequence Diagram:

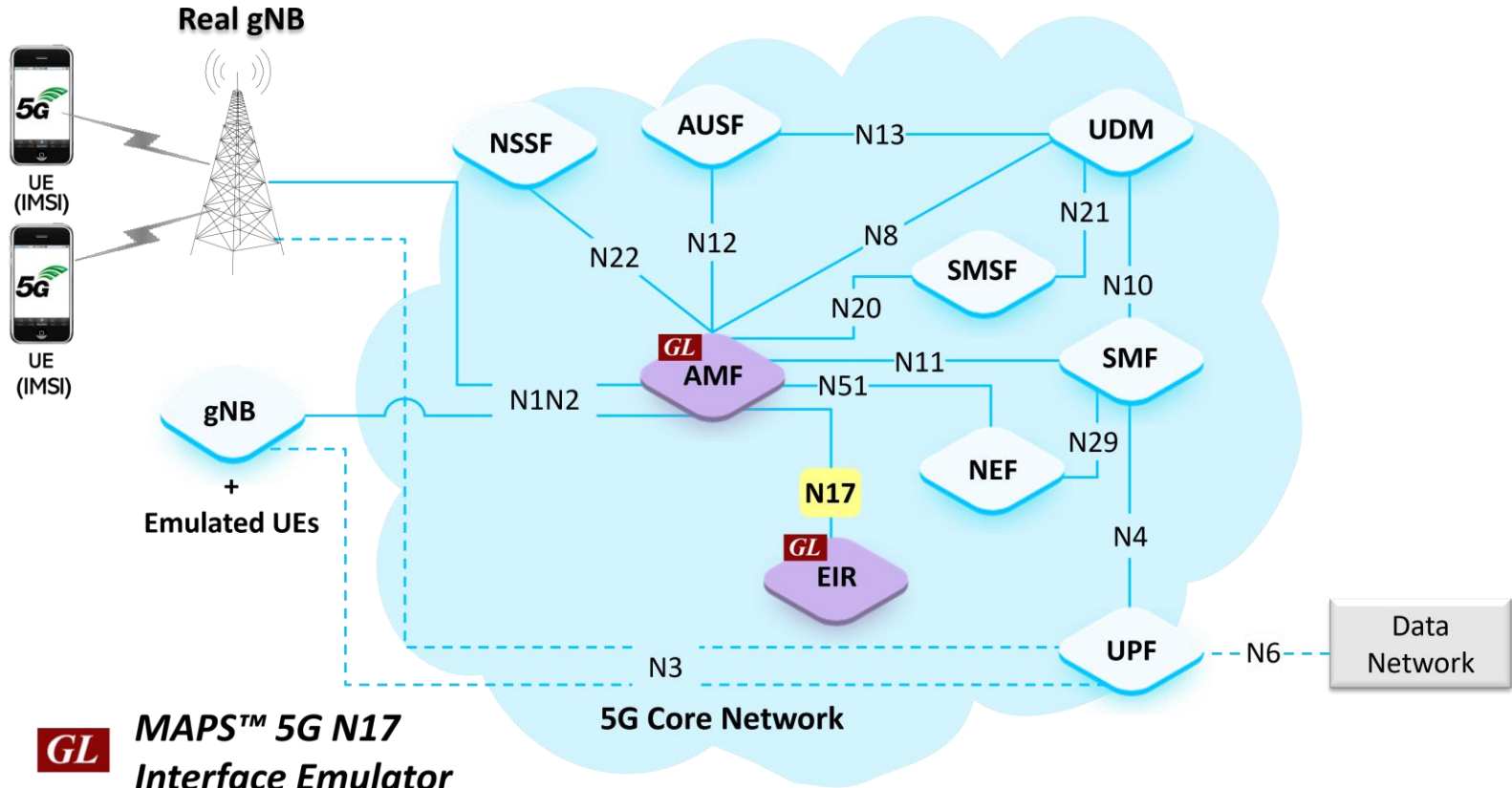
```
sequenceDiagram
    participant AUSF
    participant UDM
    AUSF->>UDM: POST /nudm-ueau/v1/suci-0-001-01-0-0-0-3012041631/security-information/generate-auth-data
    Note over AUSF,UDM: 13:01:30.169000
    UDM-->>AUSF: 200
    Note over AUSF,UDM: 13:01:30.171000
```

JSON Response:

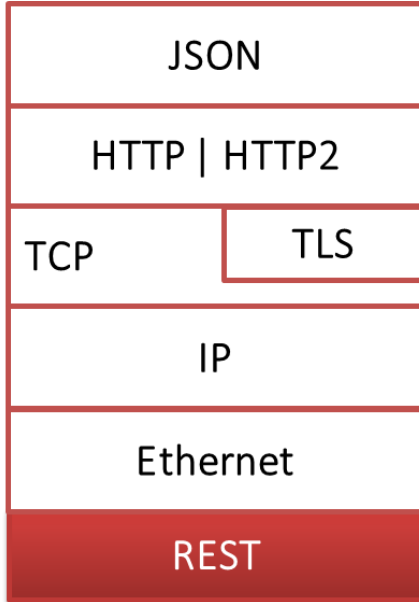
```
{
  "ausfInstanceId": "7f54c042-7ff8-4a44-b377-b8e48f0b7163",
  "servingNetworkName": "5G:mnc001.mcc001.3gppnetwork.org"
}
```

# MAPS™ 5G N17 Interface Emulation

# MAPS™ 5G N17 Network Architecture



# Protocol Stack Specification



Supported Protocols	Standard / Specification Used
N17 Interface (EIR)	3GPP TS 29.511 V17.2.0
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP	IETF RFC 7231
HTTP / 2	IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™ 5G N17 Interface - Call Emulation

MAPS AMF (N17 RELEASE17) - [Call Generation -CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterations
1	N5g-eir_AMF_Control.gls	UEProfile0002	359877068325249	Start	WHITELISTED	None	Pass	1	1
2	N5g-eir_AMF_Control.gls	UEProfile0003		Start		None	Unknown	1	0
3	N5g-eir_AMF_Control.gls	UEProfile0004		Start		None	Unknown	1	0
4	N5g-eir_AMF_Control.gls	UEProfile0005		Start		None	Unknown	1	0

Add Delete Insert Refresh Start Start All Stop Stop All Abort Abort All

Save Column Width Show Latest

AMF EIR

GET /n5g-eir-etc/v1/equipment-status?pei=imei-359877068325249&gpsi=msisdn-3012041632 12:23:18.950000

200 OK 12:23:19.016000

Scripts Message Sequence Event Config Script Flow

Initialisation Errors

MAPS EIR (N17 RELEASE17) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	EIR_HTTP2_Connection_Monitor.gls		EIR Server Clients : AMF,	Stop	Monitoring HTTP2 Connection Status	None	Unknown
2	N5g-eir_Control.gls		imei-359877068325248	Completed	WHITELISTED	None	Pass
3	N5g-eir_Control.gls		imei-359877068325249	Completed	WHITELISTED	None	Pass

Stop Stop All Abort Abort All Show Records Select Active Call Auto Trash Trash

Save Column Width Show Latest

AMF EIR

GET /n5g-eir-etc/v1/equipment-status 12:44:56.405000

200 12:44:56.406000

```
Status: 0
:method : GET
:path : /n5g-eir-etc/v1/equipment-status?pei=imei-359877068325248
:scheme : http
:authority : 192.168.12.29:6666
:accept : application/json,
application/problem+json
```

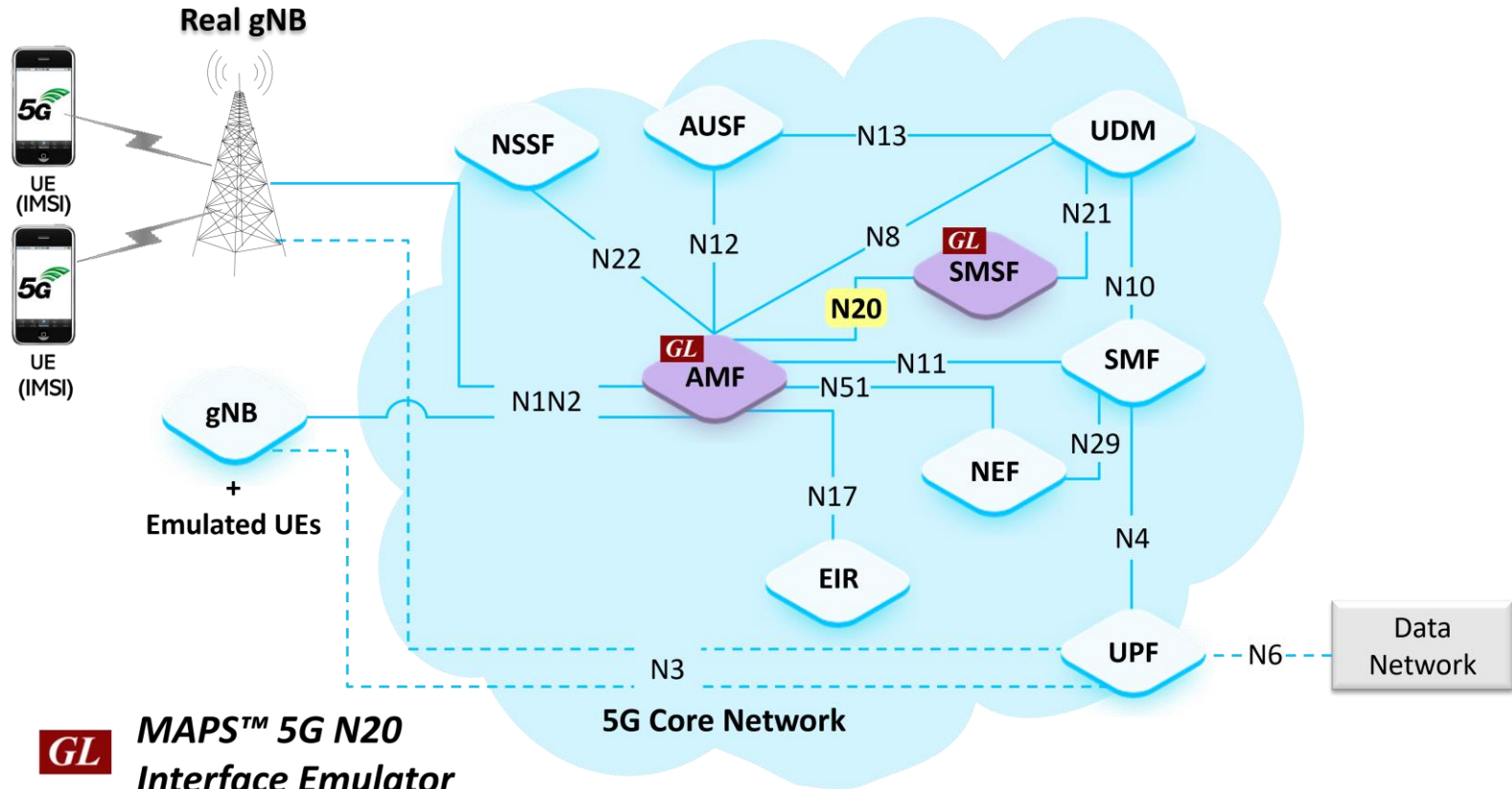
Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors



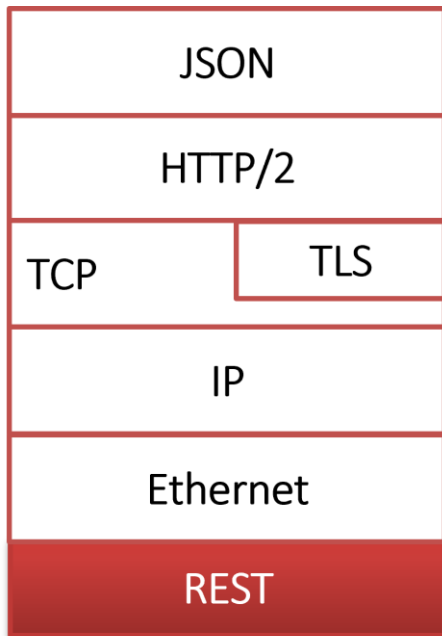
# MAPS™ 5G N20 Interface Emulation

# MAPS™ 5G N20 Network Architecture



MAPS™ 5G N20  
Interface Emulator

# Protocol Stack Specification



Supported Protocols	Standard / Specification Used
<b>N20 Interface</b>	
N20 Interface (SMSF - AMF)	TS29.540 TS29.518
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP HTTP / 2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™ 5G N20 Interface Procedures

- Nsmsf procedures
  - Registration using Activate service procedure
  - De-Registration using Deactivate service procedure
  - Send SMS payload in uplink direction procedure
  - Namf\_Communication Service procedure

# MAPS™ 5G N20 Interface - Call Emulation

## Call Generation

MAPS AMF (N20 RELEASE17) - [Call Generation - CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Executi...	Status	Events	Events Profile	Result	Total Iterations	Comp
1	Nmsmf_AMF_SMSservice_Activation.gls	MSIN3012041631	imsi-001013012041631	Start	SMSservice Activation Successful	None		Pass	1	
2	Nmsmf_AMF_Mo_SMS.gls			Start		None		Unknown	1	
3	Nmsmf_AMF_SMSservice_Deactivation.gls			Start		None		Unknown	1	

Add Delete Insert Refresh Start Start All Stop Stop All Abort Abort All

Save Column Width Show Latest

AMF SMSF

PUT /nmsmf-sms/v2/ue-contexts/imsi-001013012041631 11:07:37.660000

201 CREATED 11:07:37.956000

Scripts Message Sequence Event Config Script Flow

## Call Reception

MAPS SMSF (N20 RELEASE17) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Results
1	SMSF_HTTP2_Connection_Monitor.gls		SMSF Server Clients :	Stop	Monitoring HTTP2 Connction STatus	Connect Server		Unknown
2	SMSF_Control.gls		imsi-001013012041631	Completed	SM Service Activated	None		Pass

Stop Stop All Abort Abort All Show Records Select Active Call Auto Trash Trash Show Hidden Calls

Save Column Width Show Latest

AMF SMSF

PUT /nmsmf-sms/v2/ue-contexts/imsi-001013012041631 11:07:37.931000

201 11:07:37.948000

Status: 201  
content-type : application/json  
location : https://192.168.1.31:7777/nmsmf-sms/v2/ue-cont

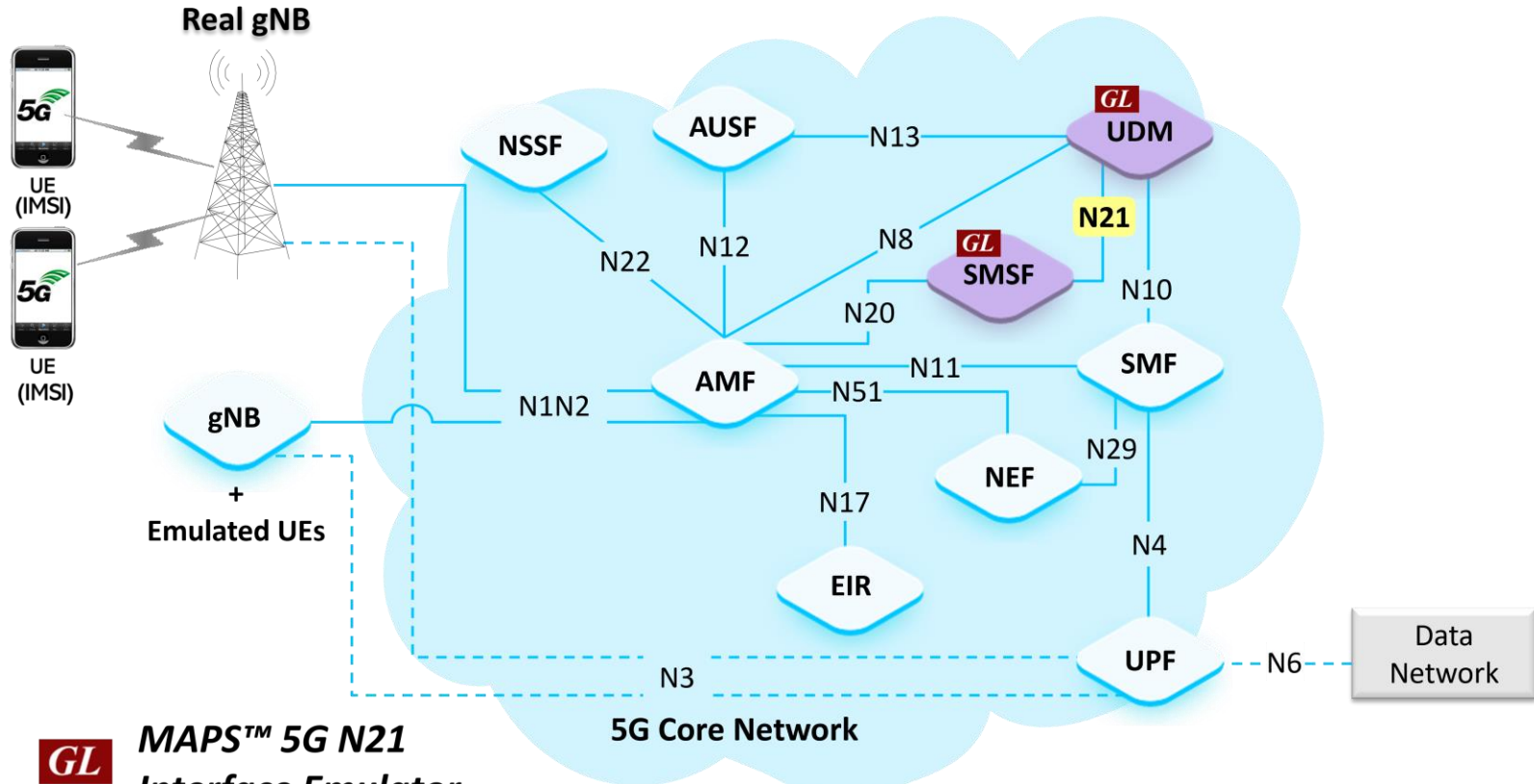
```
{
  "accessType": "3GPP_ACCESS",
  "amfId": "9300e27b-93ca-440a-905a-cc3f64a271e5",
  "ratType": "NR",
  "supi": "imsi-001013012041631"
}
```

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors Li

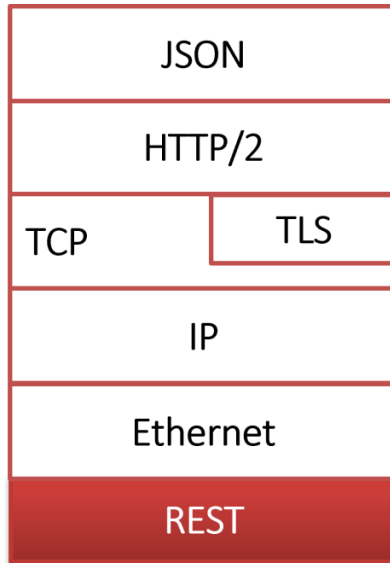
# MAPS™ 5G N21 Interface Emulation

# MAPS™ 5G N21 Network Architecture



**MAPS™ 5G N21**  
**Interface Emulator**

# Protocol Stack



Supported Protocols	Standard / Specification Used
<b>N21 Interface</b>	
N21 Interface (UDM-SMSF)	TS29.503
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP/2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]



# MAPS™ 5G N21 Interface Procedures

- **Nudm\_SubscriberDataManagement Service**
  - SMS Management Subscription Data Retrieval
  - Subscription to Notifications of Data Change
  - Unsubscribe to notifications of data change
  - Modification of a subscription to notifications of data change
- **Nudm\_UEContextManagement Service**
  - SMSF Registration for 3GPP Access
  - SMSF Registration for Non 3GPP Access
  - SMSF Deregistration for 3GPP Access
  - SMSF Deregistration for Non 3GPP Access

# MAPS™ 5G N21 Interface - Call Emulation

## Call Generation

MAPS SMSGF (N21 RELEASE17) - [Call Generation] - CallGenDefault

Sr No	Script Name	Profile	Call Info	Script Exec...	Status	Events	Events Profile	Result	Tot
1	Nudm_UECM_Control.gls	UEProfile0001	SUPI :_imsi-001013012041631	Start	SMSF Registration for 3GPP access is successful	None		Pass	

Call Log:

- PUT /nudm-uecm/v1/imsi-001013012041631/registrations/smf-3gpp-access → 17:11:55.93600
- ← 200 OK ← 17:11:56.06500

## Call Reception

MAPS UDM (N21 RELEASE17) - [Call Reception]

Sr No	Script Name	Profile	Call Info	Script Execu...	Status	Events	Ev...	Results
1	UDM_HTTP2_Connection_Monitor.gls		UDM Server Clients : AMF	Stop	Monitoring HTTP2 Connection Status	None		Unknown
2	Nudm_UECM_Control.gls		SUPI :_imsi-001013012041631	Completed	SMSF Registration is updated	None		Pass

Call Log:

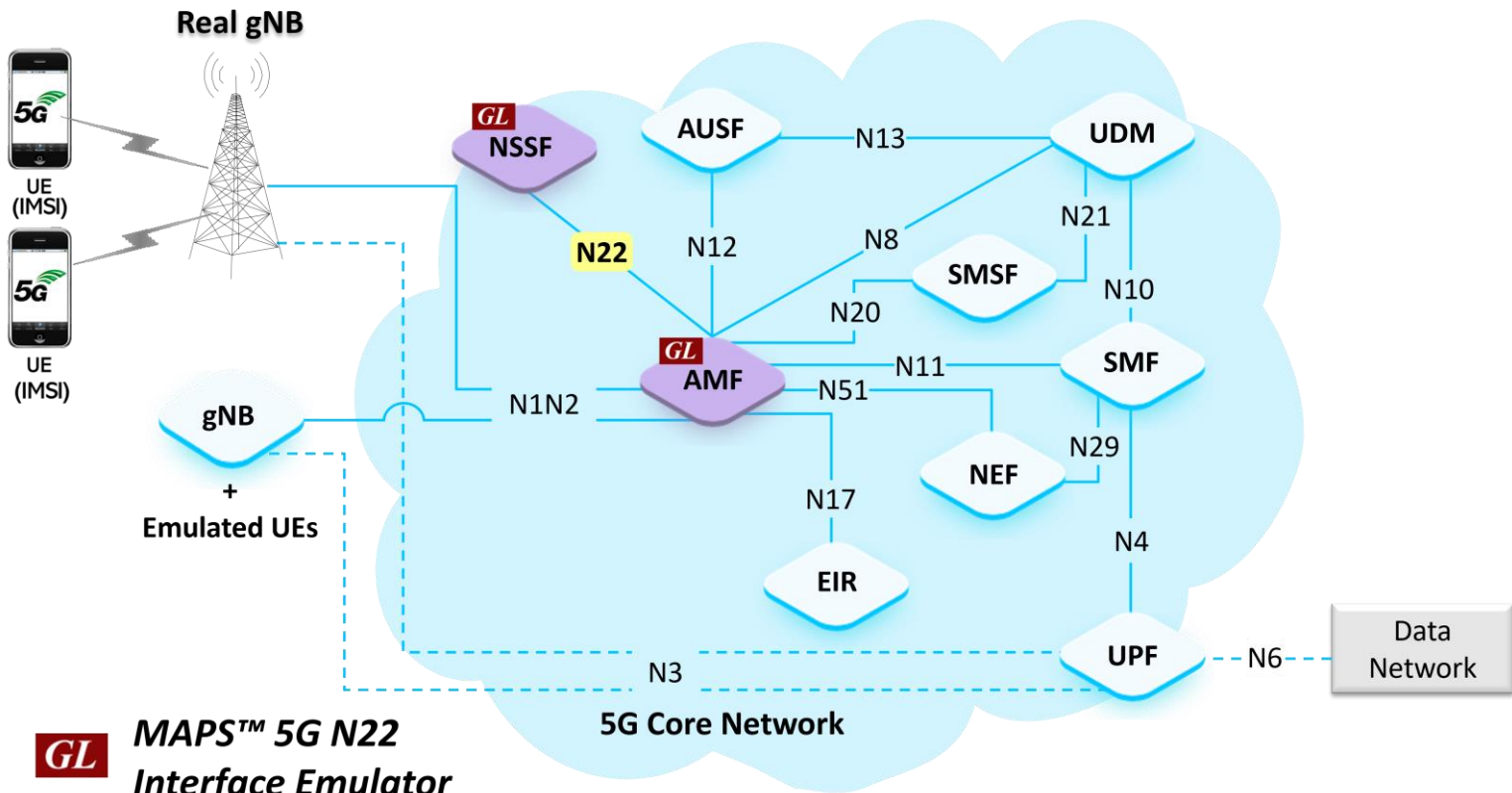
- PUT /nudm-uecm/v1/imsi-001013012041631/registrations/smf-3gpp-access → 17:26:31.518000
- ← 200 ← 17:26:31.519000

Message Details:

```
Status: 3
:method : PUT
:path : /nudm-uecm/v1/imsi-001013012041631/registrations/smf-3gpp-access
:scheme : http
:authority : 192.168.12.89:6666
:content-type : application/json
:accept : application/json, application/problem+json
:content-length : 115
{
  "plmnId": {
    "mcc": "001",
    "mnc": "01"
  },
  "smfInstanceId": "5f5a7379-0609-4b77-9a16-30b417ac8eab",
  "supportedFeatures": "0"
}
```

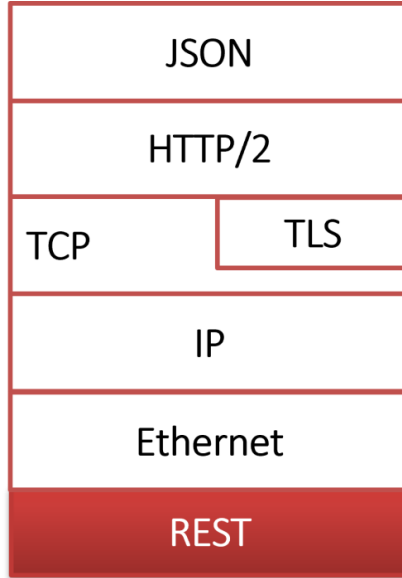
# MAPS™ 5G N22 Interface Emulation

# MAPS™ 5G N22 Network Architecture



**MAPS™ 5G N22**  
*Interface Emulator*

# Protocol Stack



Supported Protocols	Standard / Specification Used
<b>N22 Interface</b>	
N22 Interface (NSSF - AMF)	TS29.531 Release 17
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP / 2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™ 5G N22 Interface - Call Emulation

## Call Generation

MAPS AMF (N22 RELEASE15) - [Call Generation - CallGenDefault]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterations
1	Nnssf_AMF_NSSelection_Get_Request_Registration.gls	UEProfile0001	0187850d-b25f-4a9f-a...	Start	Slice Selected for Registration	None	Pass	1	1
2	Nnssf_AMF_NSSelection_Get_Request_PDUSession.gls	UEProfile0001		Start		None	Unknown	1	0
3	Nnssf_AMF_NSSAIAvailabilityPut_Request.gls	UEProfile0001		Start		None	Unknown	1	0

Message Sequence Diagram (MAPS vs DUT):

```
sequenceDiagram
    participant MAPS
    participant DUT
    Note over MAPS: GET http://192.168.1...
    MAPS->>DUT: GET /nssf-nssselection/v2/network-slice-information
    Note over DUT: 17:18:16.946000
    DUT-->>MAPS: 200 OK
    Note over MAPS: 17:18:17.021000
```

## Call Reception

MAPS NSSF (N22 RELEASE15) - [Call Reception]

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	Nnssf_NSS_Control.gls		0187850d-b35f-4a9f-a423-5b1e933...	Completed	Slice Requested for Registration Successful	None	Pass

Message Sequence Diagram (DUT vs MAPS):

```
sequenceDiagram
    participant DUT
    participant MAPS
    Note over DUT: GET http://192.168.1...
    DUT->>MAPS: GET /nssf-nssselection/v2/network-slice-information
    Note over MAPS: 17:18:17.007000
    MAPS-->>DUT: 200
    Note over DUT: 17:18:17.013000
```

Request Details:

```
Status: 0
:method : GET
:path : /nssf-nssselection/v2/network-slice-information
:scheme : http
:authority : 192.168.1.20:6666
:accept : application/json,
application/problem+json
```

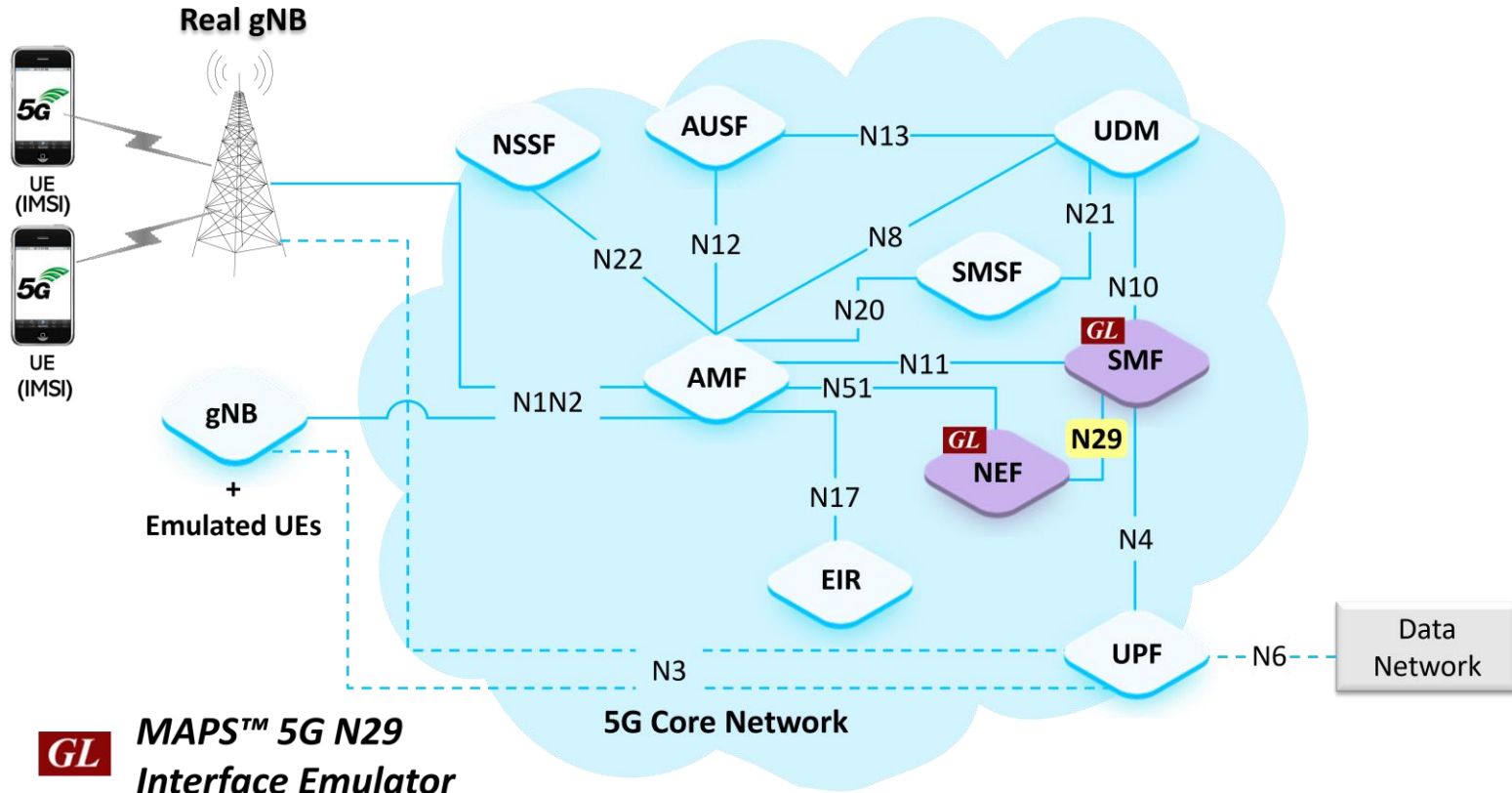
# MAPS™ 5G N22 Interface Procedures

- **Nssf\_NSSelection Service**
  - Get service operation
- **Nssf\_NSSAIAvailability Service**
  - Update Service Operation
  - Subscribe Service Operation
  - Unsubscribe Service Operation
  - Notify Service Operation
  - Delete Service Operation

# MAPS™ 5G N29 Interface Emulation

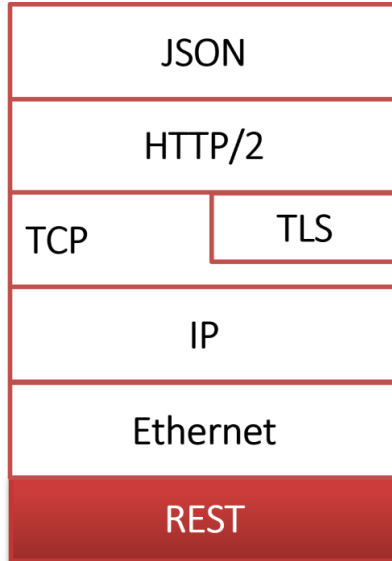


# MAPS™ 5G N29 Network Architecture



**GL** MAPS™ 5G N29  
Interface Emulator

# Protocol Stack



Supported Protocols	Standard / Specification Used
<b>N29 Interface</b>	
N29 Interface (NEF-SMF)	TS29.508 TS29.522
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP/2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP/TLS	IETF RFC 793 IETF RFC 8446
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™ 5G N29 Interface - Call Emulation

## Call Generation

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterations
1	NEF_EventExp_Control.gls	UEProfile001	SUPI :msi-001013012041631	Start	Nsmf EE SessionEstEventNotify Response Sent	None	Pass	1	1

## Call Reception

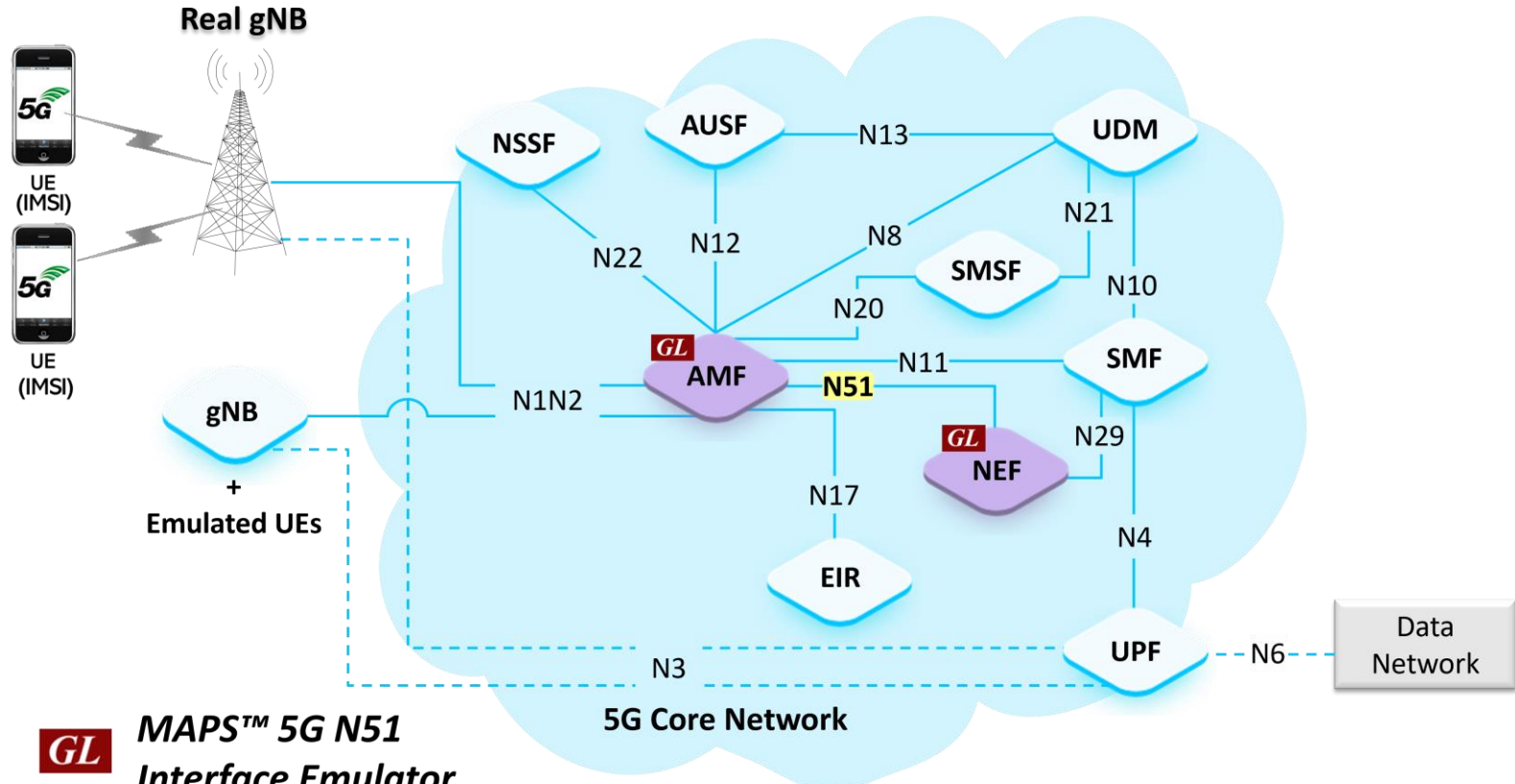
Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	SMF_HTTP2_Connection_Monitor.gls		SMF Server Clients : NEF,	Stop		Connect Server	Unknown
2	Nsmf_EventExp_Control.gls		SubId :nsmfsubid-3012041631, SUPI :msi-001013012041...	Completed	Successful Subscribe Response Sent	None	Pass
3	Nsmf_EventExp_Control.gls		SubId :nsmfsubid-3012041631, SUPI :msi-001013012041...	Completed	Nsmf EE Notify Response Received	None	Pass

# MAPS™ 5G N29 Interface Procedures

- **Nsmf\_EventExposure Procedures**
  - Subscription
  - Unsubscription
  - Notify
  - Session Management Event Exposure Event Types:
    - PDU session establishment Event
    - PDU session release Event
    - QFI allocation Event
    - UE IP address/prefix change Event

# MAPS™ 5G N51 Interface Emulation

# MAPS™ 5G N51 Network Architecture



MAPS™ 5G N51  
Interface Emulator

# Protocol Stack

JSON	
HTTP/2	
TCP	TLS
IP	
Ethernet	
REST	

Supported Protocols	Standard / Specification Used
<b>N51 Interface</b>	
N51 Interface (NEF-AMF)	TS29.518
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP/2 (Hypertext Transfer Protocol)	IETF RFC 7540
TCP/TLS	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

# MAPS™ 5G N51 Interface - Call Emulation

## Call Generation

MAPS NEF (N51 RELEASE17) - [Call Generation - CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterations
1	NEF_EventExp_Control.gls	UEProfile0001	SUPI :_jmsi-001013012041631	Start	Namf EE Se...				

Message Sequence Diagram:

- NEF sends POST /namf-evts/v1/subscriptions to AMF at 12:10:41.880000.
- AMF returns 201 CREATED at 12:10:42.253000.
- NEF sends POST /namf-evts/v1/subscriptions/notifyid-3012041631/namf\_report\_eve... to AMF at 12:10:47.787000.
- AMF returns 204 at 12:10:47.788000.

Scripts: Message Sequence | Event Config | Script Flow

● Initialisation Errors

## Call Reception

MAPS AMF (N51 RELEASE17) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	AMF_HTTP2_Connection_Monitor.gls		AMF Server Clients : .	Stop		Connect Server	Unknown
2	Namf_EventExp_Control.gls		imsi-001013012041631	Completed	Successful Subscribe Response Sent	None	Pass
3	Namf_EventExp_Control.gls		SUPI :_jmsi-001013012041631	Completed	Namf EE Notify Response Received	None	Pass

Message Sequence Diagram:

- NEF sends POST /namf-evts/v1/subscriptions to AMF at 12:10:42.238000.
- AMF returns 201 at 12:10:42.243000.

Scripts: Message Sequence | Event Config | Script Flow

● Initialisation Errors ● Error Events ● Captured Errors

```
Status: 1
method : POST
path : /namf-evts/v1/subscriptions
scheme : http
authority : 192.168.12.198:6666
content-type : application/json
accept : application/problem+json
content-length : 361

{
  "subscription": {
    "eventList": [
      {
        "immediateFlag": false,
        "type": "REGISTRATION_STATE_REPORT"
      }
    ],
    "eventNotifyUri": "http://192.168.12.170:6666/namf-evts/v1/subscripti
    "nfId": "4b7412b5-760a-41b6-a673-edc55aa6850d",
    "notifyCorrelationId": "notifyid-3012041631",
    "options": {
      "trigger": "ONE_TIME"
    }
  },
  ...
}
```



# MAPS™ 5G N51 Interface Procedures

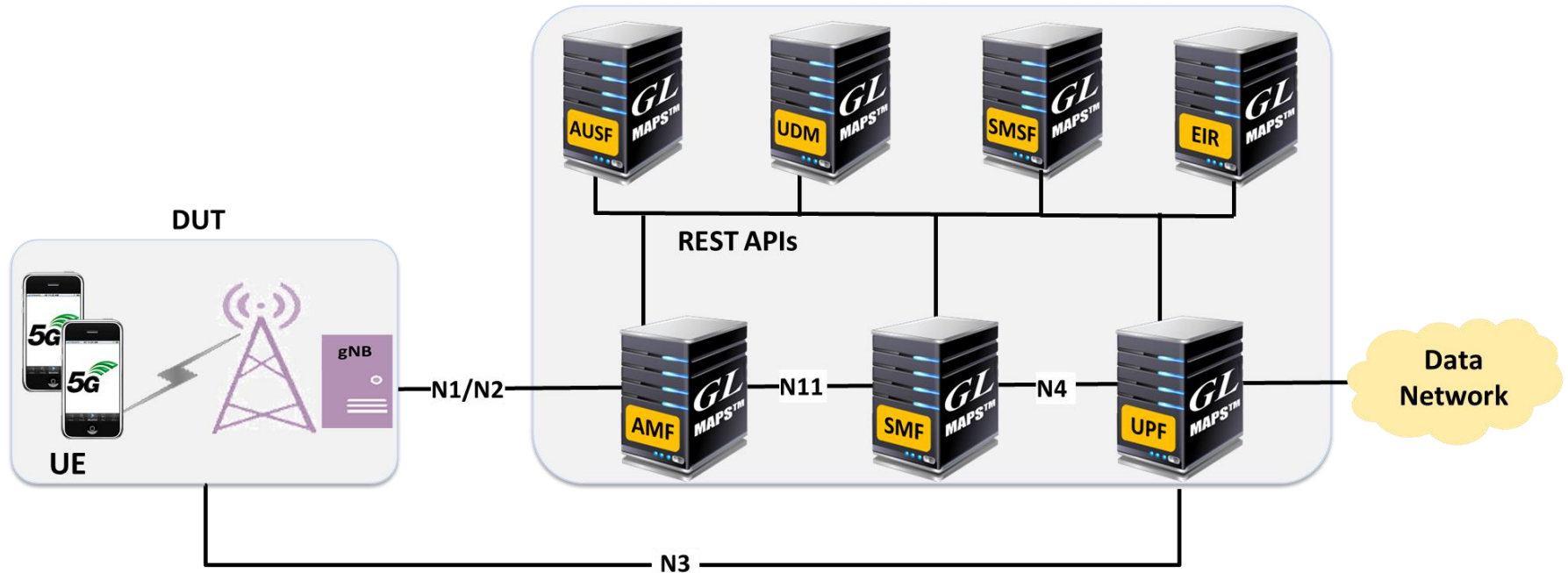
- **Namf\_EventExposure Service**
  - Subscription
  - Unsubscription
  - Notify Subscription
    - Registration State Change Event
    - Connection State Change Event
    - Location Report Event
    - Presence In Area of Interest Event

# MAPS™ 5G Use Cases

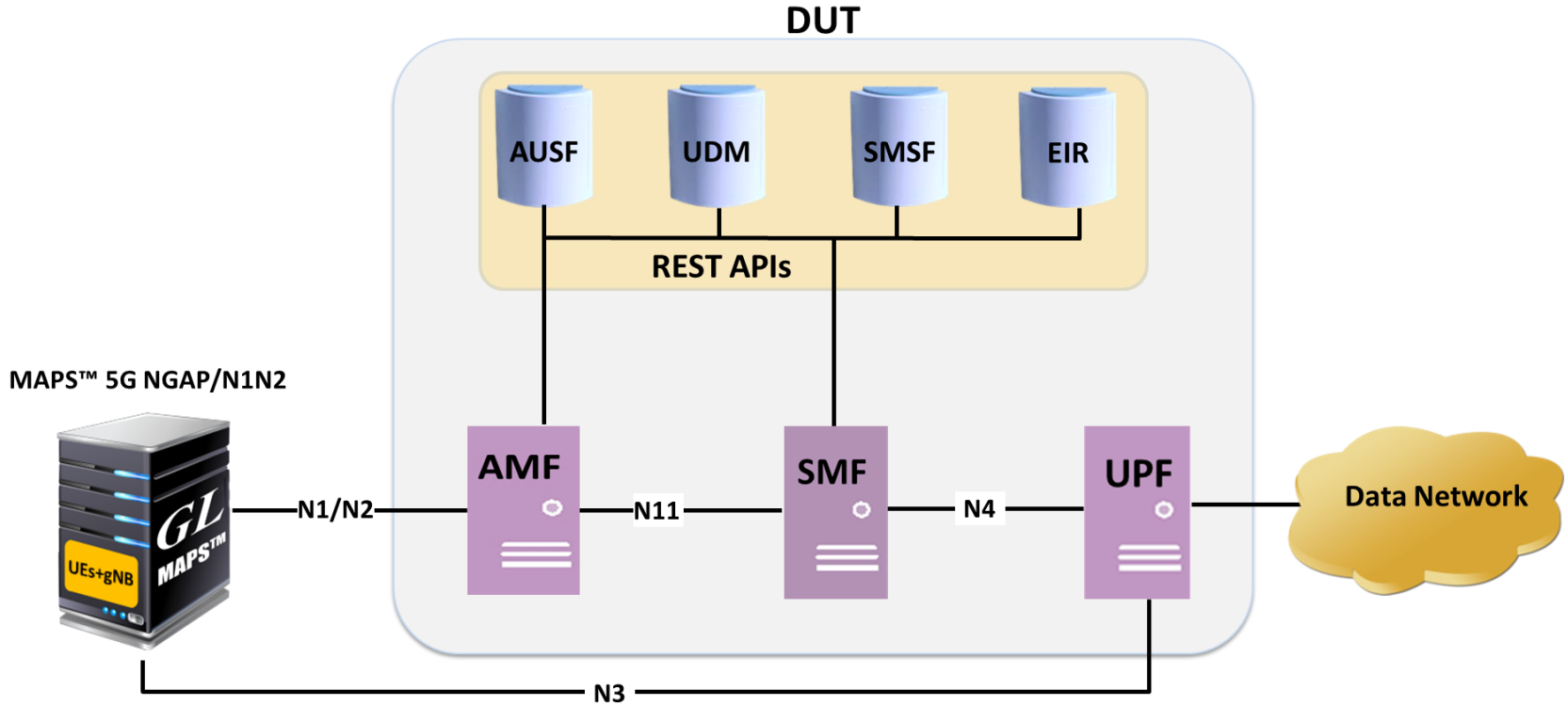
# MAPS™ 5GC Emulation (Testing gNodeB)



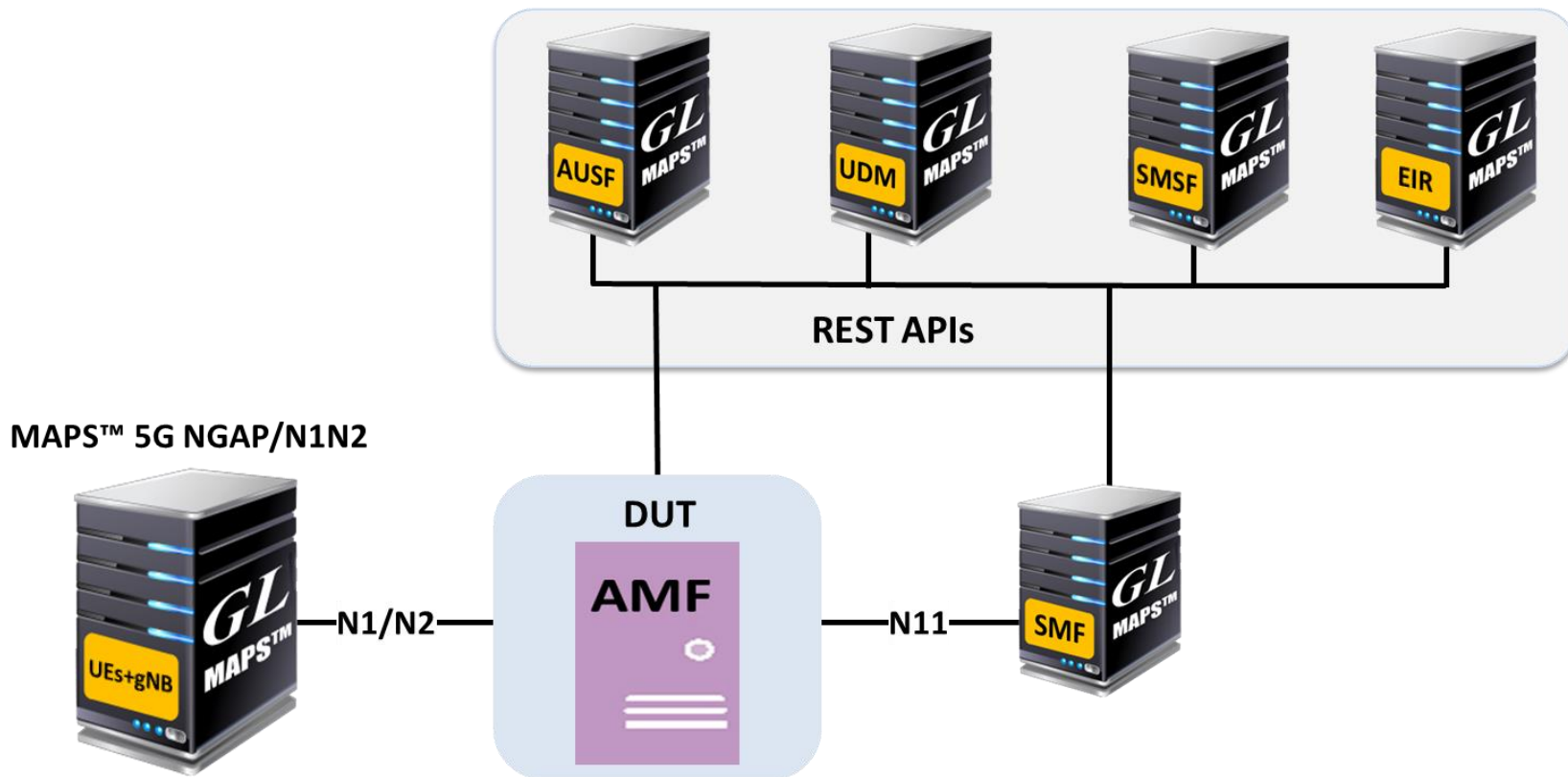
MAPS™ 5GC Emulator Suite



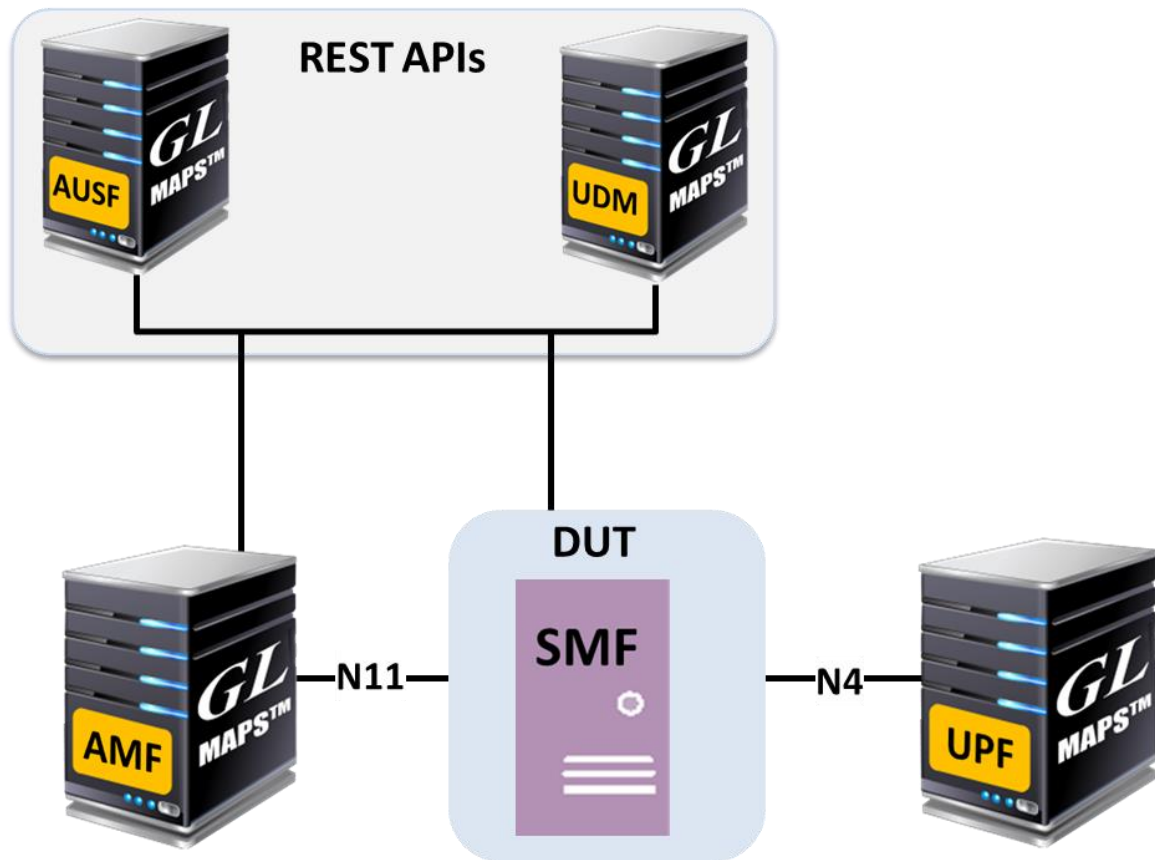
# MAPS™ gNB Emulator (Testing 5G Core Network)



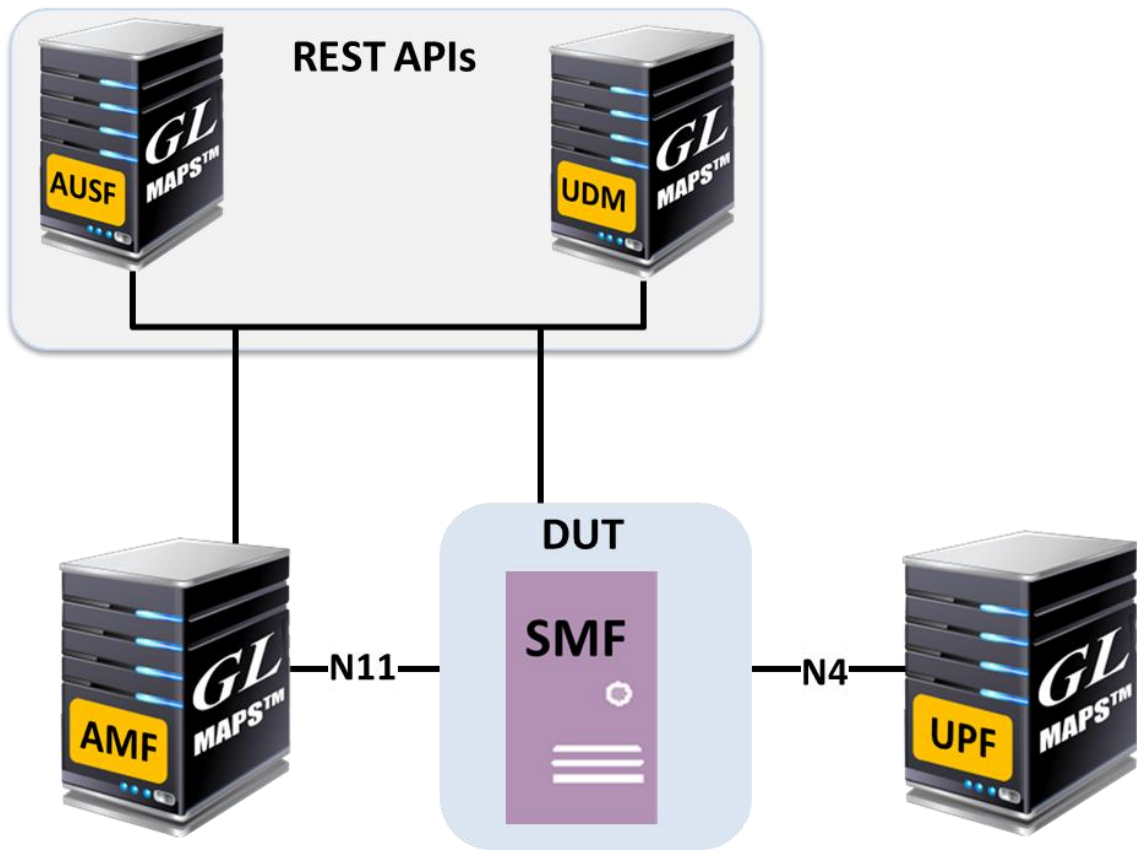
# Wrap Around Testing of AMF



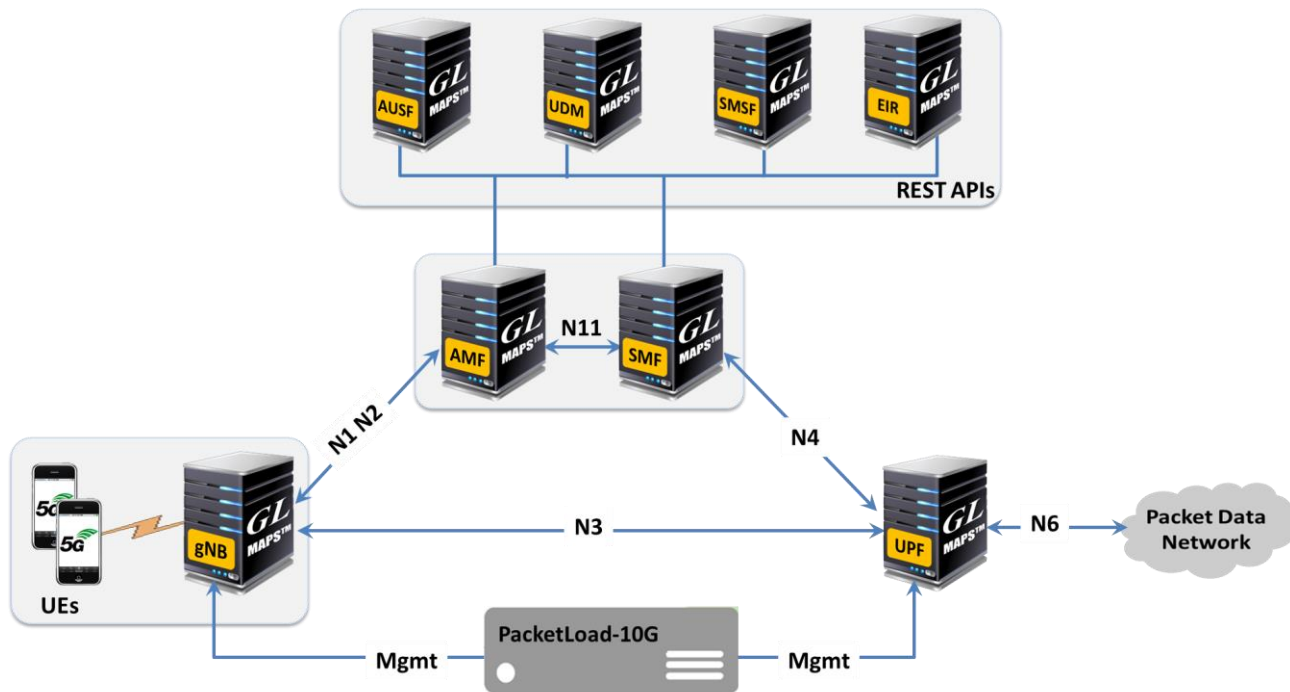
# Wrap Around Testing of SMF



# Wrap Around Testing of AUSF and UDM



# Complete 5G Network Emulation Test Suite w/ Emulated gNodeB



 **MAPS™ 5G Network LAB Test Suite**

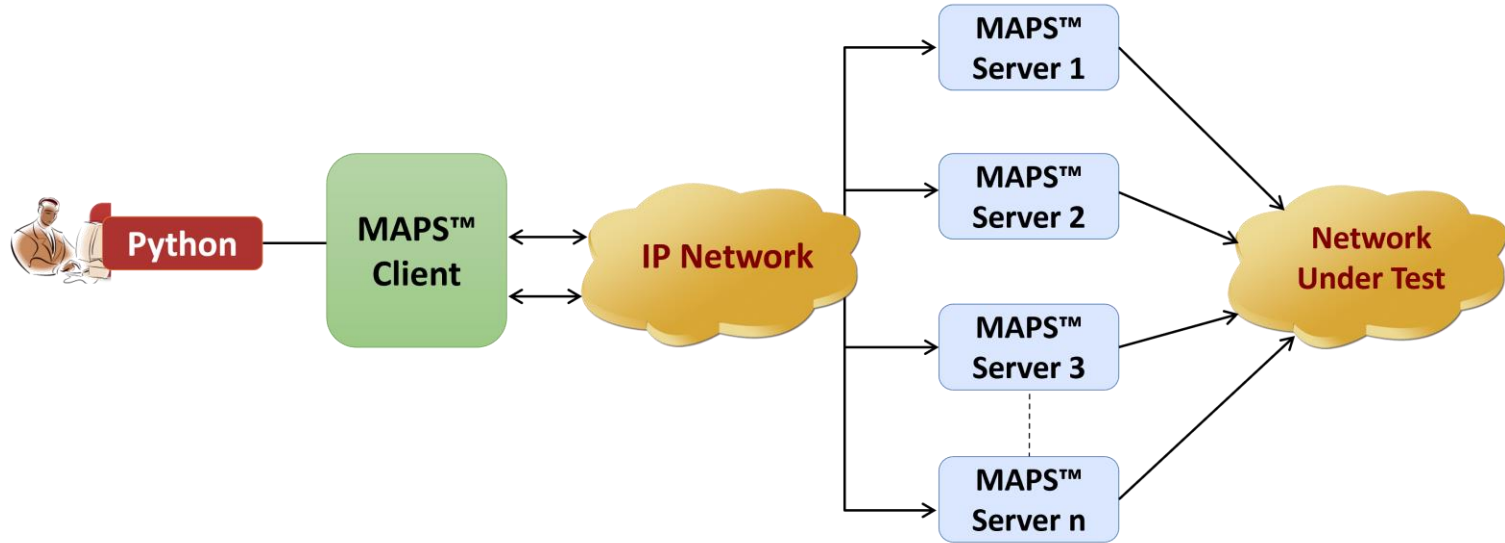


# Packet Data Traffic Generation Appliance PacketLoad™ 10G



- PacketLoad 4 x 10Gbps (PKS174) is a Data Traffic Generator 2U Rack Appliance with 4 x 10Gbps NIC interfaces: total capacity of up to 40 Gbits/sec Stateful TCP/HTTP Traffic
- It supports massive simulation of UEs (up to 500,000) with high density (up to 4 Gbps or 40 Gbps) mobile data traffic simulation for both UMTS, and LTE networks

# MAPS™ API Architecture



- API wraps our proprietary scripting language in standard languages familiar to the user:
  - Python
- Clients and Servers support a “Many-to-Many” relationship, making it very easy for users to develop complex test cases involving multiple signaling protocols

Thank you